Telephone No. 17.

Public Health Department,
County Hall,
Wakefield.

Please address all letters to
James Robt Kaye, M.B., D.P.H.
County Medical Officer.

25th May, 1910.

The Dean of the Faculty of Medicine,
Glasgow University.

Dear Sir,

Enclosed I beg to submit my Thesis for the M.D. degree. The Royal Statistical Society of England considered the results of the Life Table for Scotland of sufficient importance to publish them in their journal. The part at the beginning giving details of the working of the Life Table is new, as also is part III.

In Part I an effort has been made to systematise and so render more easy to follow a subject of some difficulty. PartIII is largely occupied in showing how the Life Table for Scotland has been affected by Phthisis and Other Tuberculous Diseases.

The work has been done, and the Thesis composed by myself.

I should be glad to know if I can present myself in October for the clinical examination for the M.D. In your letter of May 6th nothing was said of the clinical examination. I understand from your note that by Ordinance the degree of M.D. cannot be conferred on me until a year has elapsed from the conferring of the M.B. degree, - that is in April 1911 at the earliest.

I should esteem it a favour to be enlightened on the above, and I crave your indulgence for again troubling you.

Yours sincerely,

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CONTENTS.

LIFE TABLE FOR SCOTLAND. 1891 - 1900.

PRELIMINARY OBSERVATIONS. The construction of a life-table may be compared to a business man's taking stock and making a critical analysis of all his records over an extended period. A simple annual statement of profit and loss would suffice in a business which is limited to direct dealings on a simple scale, but where there are diverse operations extending over a wide field of activities a short-sighted summing up will not show the exact state of the business, and it is necessary to make the review more analytical in detail and more extended in scope if we are to observe the true effect of slowly operating tendencies and to discount temporary influences.

Similarly, a limited review of births and deaths is not capable of showing all that it is desirable to know for properly gauging the vitality of a people. A life-table on the other hand provides us with the means of projecting before our view a generation of individuals passing through life under the conditions which prevailed in a given decade. By making a series of life-tables based on the lives and deaths of successive periods the most accurate means of comparison possible can be established of the vitality and sanitary conditions of the people during the separate periods. The results obtained can be compared with those of other countries. Besides, a life-table for a country as a whole serves as a standard by which the results of life-tables wrought out for particular towns or districts can be compared. It is notorious that the death-rates in towns are generally very unfavourable, when compared with those of a country as a whole. Under improved sanitary conditions, however, this inequality has been steadily disappearing. The rate of levelling-up could best be observed by a series of life-tables. For several decennia life-tables have been regularly constructed for England. The same cannot be said for Scotland, although in the detailed report of the Registrar General for Scotland, 1873, a Life-Table for Scotland by William Robertson, M.D., is given, based on the Census enumeration of 1871, and on the Registered Deaths of that year.

PART I. DATA FOR LIFE-TABLE AND CONSTRUCTION OF SAME.

Different methods might be pursued to get the basis of a life-table. In the first place it is essential to know the number and the ages of the living, and the number and ages of the dying. A method which therefore suggests itself is to trace through life a generation of individuals. As deaths among them occurred, the year of death, and the total years lived by each, could be noted, until all were extinct. The number of individuals beginning and ending each year of life would thus be known, and from this the probabilities of life and death for each year could readily be calculated. The probabilities for all the years of life having been obtained, the construction of the life-table could be proceeded with. In such a method the observations would of necessity extend over the life-time of all the individuals composing the generation. During this period, the conditions (social, sanitary, etc.) of life, would be constantly changing, and thus, while the probability of life for each year would correctly state the chance of living a year under the same conditions as when the year was lived, very misleading results would be obtained, should these probabilities be applied under new and different conditions. A great error in our vital statistics would

would result, if the probabilities of living, which held good even fifty years ago, were accepted as correct to-day, as the Science of Hygiene, since the passing of the Public Health Acts, has made enormous advances.

From the above it will be understood that it would be advantageous to have the data, upon which to base a Life Table, obtained from a period as near as possible to the present. The less remote the period from which the figures are obtained, the more accurately will they express the vitality of the people under existing conditions. It must be remember-ed, however, that only an approximate accuracy can be attained when the results obtained from a former period are applied to the present, for in a few years the conditions of life may be so altered as to materially change the rates of mortality for the different age periods. Supposing the rates are lowered the probabilities of life are increased, a greater number of sur-vivors pass on to each age period, the total number of years lived is augmented, and so also is the mean after-lifetime.

In tracing a generation of individuals through time, the continuous decrease in their number will become very appar-ent,- a decrease most marked at the two extremes of life. The probability of living a year for each year of life varies inversely as the rate of mortality for the year, that is to say, the higher the rate of mortality the lower the probability of life, and vice versa. From this it follows that, if the probability of life for each year be increased by improved conditions, not only will succeeding periods contain more indi-viduals, but the point of time, at which all will have died, will be postponed. This increase in the total years lived can be accurately ascertained, and can be taken as a direct measure of increase of vitality. The connection for those interested in Public Health is this:- The probabilities of life/

life depend on a population's vitality, which again is indicated by the rates of mortality, for the higher the vitality the lower the mortality, and, finally, the rates of mortality are almost universally used as an index of the sanitary conditions under which a population is living. The basis now usually adopted in the construction of a general Life-Table is obtained from the results of two con--secutive Census Returns, and from the deaths registered during the corresponding decennium. For the present Life-Table for Scotland, the Census enumerations of 1891 and 1901, and the registered deaths of the decennium 1891 to 1900, supply the figures. The "Graphic Method," so ably advocated by Dr. Newsholme, has been followed.

The above figures being comparatively recent, the results obtained from them, when applied to the present, will be all the more trustworthy, since the conditions affecting the duration of life will have had less time to undergo change.

The Census Returns for Scotland for 1891 and 1901 are given in Tables I and II, and show the following numbers and age distribution of the population:-

TABLE I.

Census Populations of 1891 and 1901.

A g e s.	M a l e s.	
	1891.	1901.
Under 1 year,	54,723	58,018
" 2 years,	48,573	52,771
" 3 "	51,030	53,294
" 4 "	50,352	52,293
" 5 "	50,104	51,986
0 - 5	254,782	268,362
5 - 10	241,726	249,312
10 - 15	229,237	238,288
15 - 20	210,954	230,353
20 - 25	174,108	210,392
25 - 35	274,142	332,267
35 - 45	211,053	251,339
45 - 55	158,630	184,159
55 - 65	105,140	121,172
65 - 75	58,550	63,290
75 - 85	21,344	22,023
85 - 95	2,943	2,697
95 -105	108	101
105 & above,	-	-
TOTALS,	1942,717	2173,755

TABLE II.

A g e s.	F e m a l e s.	
	1891.	1901.
Under 1 year,	52,929	56,667
" 2 years,	47,252	51,802
" 3 "	49,362	52,818
" 4 "	49,469	52,341
" 5 "	48,597	51,043
0 - 5	247,609	264,671
5 - 10	235,868	243,435
10 - 15	223,003	231,034
15 - 20	207,435	225,682
20 - 25	189,512	222,896
25 - 35	308,890	361,915
35 - 45	231,531,	271,990
45 - 55	186,568	201,180
55 - 65	132,363	147,199
65 - 75	81,369	87,632
75 - 85	33,246	35,117
85 - 95	5,303	5,324
95 -105	230	270
105 & above,	3	3
TOTALS,	2,082,930	2298,348

The total deaths, which occurred during the decennium 1891-1900, are also apportioned to their proper age periods as shown in Tables VII and VIII. In the first quinquennium, however, the Registrar General states the deaths for each year, and further subdivides those of the first year into three periods, viz., those under three, six, and twelve months respectively.

It will be noticed that the Census Returns give those living in age periods 0-5, 5-10, etc., Experience has shown that this method is much less misleading than to attempt to give those living at each year of age. For the same reason the Registrar General's Returns of deaths are given in age periods.

Another fact to be remembered is that the Census is taken at the end of the first quarter of the year. Now, for the present purposes the population at the end of the second quarter, i.e., on June 30th, must be obtained, and this is called the Central Population.

The increase of population resulting per unit per annum has first to be calculated, and this is called "r". It will be seen that the population in 1901 is greater at each age period than in 1891. Now a close approximation to the facts is obtained by assuming that a population increases in geometrical progression:- The increase is therefore a matter of compound interest.

If **r** is the increase per unit per annum, then 1 at the end of the first year becomes $1(1 + r)$, at the end of the second year $1(1 + r)^2$, at the end of the third year $1(1 + r)^3$, and at the end of the n^{th} year $1(1 + r)^n$. In the same way P at the end of the n^{th} year will become $P(1 + r)^n$.

If/

If P = population at Census of 1891, and

P_1 = " " " 1901,

then $P_1 = P(1 + r)^{10}$

$$\therefore \log(1 + r) = \frac{\log P_1 - \log P}{10}$$

As P_1 and P are known quantities, the value of (1 + r) can be obtained from a table of logarithms. It is convenient to let (1 + r) = R, which is the population resulting per unit per annum.

In Tables III and IV the value of R for each of the age periods in the Census returns of 1891 and 1901 has been calculated:-

TABLE III.

A g e s.	M a l e s.			
	Populations for the different age-periods.		Value of R for each Age-period.	Logarithm of R for each Age-period.
	1901.	1891.		
0 - 5	268,362 =	$254,782R^{10}$	1.0052063	.002255232
5 - 10	249,312 =	$241,726R^{10}$	1.003095	.00134198
10 - 15	238,288 =	$229,237R^{10}$	1.0038797	.001681743
15 - 20	230,353 =	$210,954R^{10}$	1.008836	.003820613
20 - 25	210,392 =	$174,108R^{10}$	1.01910997	.00822105
25 - 35	332,267 =	$274,142R^{10}$	1.019415	.00835116
35 - 45	251,339 =	$211,053R^{10}$	1.0176228	.00758683
45 - 55	184,159 =	$158,630R^{10}$	1.0150344	.00648076
55 - 65	121,172 =	$105,140R^{10}$	1.014293	.00616343
65 - 75	63,290 =	$58,550R^{10}$	1.007815	.00338082
75 - 85	22,023 =	$21,344R^{10}$	1.0031366	.00136007
85 - 95	2,697 =	$2,943R^{10}$	.991309	$\bar{1}$.99620906
95 -105	101 =	$108R^{10}$	.9933213	$\bar{1}$.99708976
105 & above	-	-	-	-

TABLE IV.

Ages.	Females. Populations for the different Age-periods. 1901.	1891.	Value of R for each Age-period.	Logarithm of R for each Age-period.
0 - 5	264,671 =	$247,609R^{10}$	1.006686	.00289399
5 - 10	243,435 =	$235,868R^{10}$	1.003163	.0013714
10 - 15	231,034 =	$223,003R^{10}$	1.003544	.00153652
15 - 20	225,682 =	$207,435R^{10}$	1.0084666	.003661489
20 - 25	222,896 =	$189,512R^{10}$	1.0163576	.00704656
25 - 35	361,915 =	$308,890R^{10}$	1.0159685	.00688028
35 - 45	271,990 =	$231,531R^{10}$	1.0162355	.00699437
45 - 55	201,180 =	$186,568R^{10}$	1.0075688	.003274766
55 - 65	147,199 =	$132,363R^{10}$	1.0106802	.004613821
65 - 75	87,632 =	$81,369R^{10}$	1.0074427	.00322037
75 - 85	35,117 =	$33,246R^{10}$	1.00549004	.0023778
85 - 95	5,324 =	$5,303R^{10}$	1.0003952	.00017164
95 -105	270 =	$230R^{10}$	1.0161634	.0069636
105 & above	3 =	$3R^{10}$	1	0

R having been found for each age-period, the central populations are next obtained. As a population in--creases in geometrical progression, and as, from the Census returns of 1891 and 1901, the populations for each age-period is known for ~~April 30th~~ March 31st of each of these years, the populations for the different age-periods can be calculated for June 30th by the Formula $P_1 = PR^{\frac{1}{4}}$. By this means the central populations have been got, as shown in Tables V and VI. -

TABLE V/

TABLE V.

Males.		
Ages.	Central Population for each Age-Period.	
	1891.	1901.
0 - 5	255,113	268,711
5 - 10	241,913	249,505
10 - 15	229,459	238,519
15 - 20	211,418	230,860
20 - 25	174,934	211,390
25 - 35	275,463	333,868
35 - 45	211,977	252,439
45 - 55	159,223	184,847
55 - 65	105,514	121,603
65 - 75	58,664	63,413
75 - 85	21,361	22,040
85 - 95	2,937	2,691
95 -105	108	101
105 & above.	-	-

TABLE VI.

Females.		
Ages.	Central population for each Age-Period.	
	1891.	1901.
0 - 5	248,022	265,112
5 - 10	236,054	243,627
10 - 15	223,200	231,238
15 - 20	207,873	226,158
20 - 25	190,282	223,802
25 - 35	310,116	363,351
35 - 45	232,465	273,087
45 - 55	186,920	201,560
55 - 65	132,715	147,590
65 - 75	81,520	87,795
75 - 85	33,292	35,165
85 - 95	5,304	5,325
95 -105	231	271
105 & above.	3	3

The/

The central populations for each of the age-periods of 1891 and 1901 having been obtained, the total number of lives at risk i.e., the aggregate central populations, are then calculated for the decennium 1891-1900. That is done in the following manner. If P = central population of 1891, then PR - that of 1892, PR^2 - that of 1893, ------------ and PR^9 = that of 1900. By summing these successive central populations $P + PR + PR^2 + PR^3 + PR^4 + \text{---------} + PR^9$, the total number of lives at risk during the decennium is obtained.

Now $P + PR + PR^2 + PR^3 + \text{---------} + PR^9$ is the summation of a geometric series, which can be written thus:-

$P(1 + R + R^2 + R^3 + \text{--------} + R^9)$.

$$\text{Now } P(1 + R + R^2 + R^3 + \text{-------} + R^9) = P\left(\frac{R^{10} - 1}{R - 1}\right) = \frac{PR^{10} - P}{R - 1}$$

The above formula means that the aggregate central populations can be obtained for the decennium by subtracting the central populations of 1891 from that of 1901, and dividing the differ--ence by the rate of increase per unit per annum. This has been performed for each age-period with the following result:-

TABLE VII.

Males.			
Ages.	Total number of lives at risk in the 10 yrs. 1891 - 1900.	Total number of deaths in the 10 years 1891 - 1900.	Mean Annual Death-rate for each life at risk. 1891 - 1900.
0 - 5	2,611,836	143,414	.0549093
5 - 10	2,452,989	12,053	.0049136
10 - 15	2,335,232	7,425	.0031796
15 - 20	2,200,317	11,341	.0051543
20 - 25	1,907,695	13,061	.0068465
25 - 35	3,008,241	23,203	.0077131
35 - 45	2,296,003	26,232	.0114251
45 - 55	1,704,358	32,432	.0190289
55 - 65	1,125,656	40,251	.0357578
65 - 75	607,678	41,541	.0683602
75 - 85	216,476	29,919	.1382093
85 - 95	28,305	7,918	.2797386
95 -105	1,048	447)	.5209924
105 & above.		99)	
All Ages	20,495,834	389,336	·0189958

TABLE VIII.

Females.			
Ages.	Total number of lives at risk in the 10 yrs. 1891 - 1900.	Total number of deaths in the 10 years 1891 - 1900.	Mean Annual Death rate for each life at risk, 1891 - 1900.
0 - 5	2,556,087	121,277	.0474464
5 - 10	2,394,246	12,563	.0052472
10 - 15	2,268,059	8,187	.0036097
15 - 20	2,159,663	11,191	.0051818
20 - 25	2,049,200	12,328	.0060160
25 - 35	3,333,751	25,997	.0077981
35 - 45	2,502,048	26,046	.0104099
45 - 55	1,934,256	29,448	.0152245
55 - 65	1,392,764	40,519	.0290925
65 - 75	843,108	49,174	.0583247
75 - 85	341,163	41,286	.1210155
85 - 95	53,138	13,493	.2539237
95 -105	2,475)	1,006)	.4051896
105 & above.	30)	9)	
All Ages.	21,829,988	392,524	.0179809

Once the total number of lives at risk have been calculated, they may be said to have been brought into line with the total deaths for the decennium, as obtained from the Registrar General's report.

The point that has now been reached is that the aggregate central populations and the aggregate deaths have been obtained for age-periods. The next step is so to distribute these populations and deaths that the proper number will be apportioned to each year of the age-periods. This process is termed "Interpolation," and it is usually accomplished by the Analytical or by the Graphic method. The latter, which has been carried out here, was used first by Milne in the construction of the Carlisle Table of Mortality and quite recently by Dr. Newsholme in both his Brighton Life Tables.

The following is a short description of the method:- An abscissa or base line AB is first drawn as in fig.I. From A a perpendicular AC is raised, with the values for the different portions marked on the margin. Along the abscissa line/

line from A equal portions are marked off to represent the age-periods 0-5, 5-10, -------, 20-25. Continuing after this to the right, eight equal divisions are marked off, double the length of the first, to represent ten-yearly periods 25-35, 35-45, etc. The abscissa line having been so divided, on the divisions are then erected rectangular parallelograms, each of whose area, obtained by multiplying the marginal value by the figure representing the length of the base, will equal the total lives at risk for each age-period. For example, the base of the parallelogram AD = 5, and the marginal value AE = 522367.2. Therefore 522367.2 X 5 = the area = 2611836 = the total lives at risk for the age-period 0-5.
For the ten-yearly periods it must be remembered that the base line represents ten.

The populations at the different age-periods having been so represented, the population for each year of life is ob-tained in the following manner:- A curved line beginning at F is described, which sweeps through the upper part of the parallelograms in such a way as to add to each parallelogram as much as it cuts off, e.g., EFG = DGH, and KLM = MNO, and so on. This line must conform to certain rules, (1) it must be as little curved as other conditions will permit of, (2) it must never change its direction suddenly. If, now, each of the base lines representing five years be divided into five equal parts, and those representing ten years into ten equal parts, each part will stand for one year. Perpendiculars, drawn from the centre of each of these parts to the curved line above, will represent the total lives at risk for each year of age. If the curve has been accurately described, the sum of the ordinates in each area drawn from the base to the curved line above will be equal to the area. Thus in the age-period

5/

5-10 for Males, the ordinates represent 503,800, 496,519, 489,930, 483,625, 479,115. These added give the sum of 2,452,989, which is the area representing the total lives at risk for the age-period 5-10.

Fig. II shows the total lives at risk of females distributed.

Precisely the same method of Interpolation is employed to distribute the total deaths, given in groups of ages, as that used in dealing with the total lives at risk. The curves of distribution of total deaths are seen in fig.III for males, and fig. IV for females, and the results of the interpolation are given in Tables I and II appended.

Although the Graphic method of Interpolation gives accurate results for the greater part of life, it cannot be depended upon for the first five years, or for the age groups at the end of life. The total number of lives 0-5 may be taken as accurate, but the ages of children are often recorded very inaccurately both at the Census and at death. Again, the dis--tribution of deaths in the first five years is very unequal. The fourth year of life has a higher death-rate than the fifth, the third has a higher than the fourth, the second than the third, while the first has an enormous mortality as compared even with the second. Going still further, the mortality in the earlier months of the first year far exceeds that in the later. The results obtained by the Graphic Method would therefore be very misleading, so that the age-period 0-5 must be dealt with in some other way. The following which is a method described by Dr. Hayward, has been got from Dr. Newsholme's "Vital Statistics":-

For the ten years 1891-1900 the data required are:

(1) The true mean numbers living for each sex at the age period 0-5, calculated by the method already described.

(2) The/

(2) The numbers of births, males and females, for each of the years 1886-1900.

(3) The numbers of deaths for each sex,

(a) At age 0-1 for the years 1887-1900.
(b) " 1-2 " " 1888-1900.
(c) " 2-3 " " 1889-1900.
(d) " 3-4 " " 1890-1900.

I. The mean annual number at birth in the ten years 1891-1900.

$$= \frac{\frac{1}{2}\text{ births in 1890} + \text{all births in 1891-1899} + \frac{1}{2}\text{ biths in 1900}}{10}$$

II. The mean annual number at one year of age.

$$= \frac{\begin{array}{c}\frac{1}{2}\text{ births in 1889} + \text{all births in 1890-1898} + \frac{1}{2}\text{ births in 1899} \\ \text{less number of deaths under 1 year of age in 1890-1899.}\end{array}}{10}$$

III. The Mean Annual number at two years of age.

$$= \frac{\begin{array}{c}\frac{1}{2}\text{ births in 1888} + \text{all births in 1889-1897} + \frac{1}{2}\text{ births in 1898} \\ \text{less deaths under 1 year in 1889-1898} \\ \text{and deaths 1-2 years in 1890-1899}\end{array}}{10}$$

IV. The Mean Annual Number at three years of age.

$$= \frac{\begin{array}{c}\frac{1}{2}\text{ births in 1887} + \text{all births in 1888-1896} + \frac{1}{2}\text{births in 1897} \\ \text{less deaths under 1 year in 1888-1897} \\ \text{and deaths 1-2 years in 1889-1898} \\ \text{and deaths 2-3 years in 1890-1899}\end{array}}{10}$$

V. The Mean Annual Number at four years of age.

$$= \frac{\begin{array}{c}\frac{1}{2}\text{ births in 1886} + \text{all births in 1887-1895} + \frac{1}{2}\text{ births in 1896} \\ \text{less deaths under 1 year in 1887-1896} \\ \text{and deaths 1-2 years in 1888-1897} \\ \text{and deaths 2-3 years in 1889-1898} \\ \text{and deaths 3-4 years in 1890-1899}\end{array}}{10}$$

Five numbers are thus obtained a, b, c, d, e,

"a" representing the mean annual number at birth,
"b" " " " at one year of age,

and/

and so on. These numbers then do not pepresent the central populations.

Let $a + b + c + d + e = N$

Now the total lives at risk at the age period 0-5 having already been calculated for the ten years, the true mean annual number C is obtained by taking one-tenth of these.

If to C be added the mean annual number of deaths occurring in the first half of the first five years of life, a value T is obtained. Thus :-

C + mean annual number of those dying under 6 months of age,

$$+ \frac{\text{mean annual number of deaths at ages 1-2, 2-3, 3-4, 4-5}}{2}$$

= T.

Any difference between T and N must be due to migration. It is assumed that the migration of children under 5 years of age is proportionate for each of the years, and then T is divided proportionately to the numbers a, b, c, d, e, which give the total N. Thus -

(1) $N : T :: a : P_0$

(2) $N : T :: b : P_1$

(3) $N : T :: c : P_2$

(4) $N : T :: d : P_3$

(5) $N : T :: e : P_4$

Five numbers are thus obtained, P_0, P_1, P_2, P_3, P_4, which allow for migration, and give the true mean annual number starting at birth, at one year of age, and so on. It must be remembered that these are not the ~~true~~ mean annual number of lives at risk.

As the total deaths for the decennium at each of these years of life are known, the mean annual number of deaths can be got by dividing by ten. From the foregoing numbers the p_x values for the/

the first five years can be calculated in this way:-

$$p_0 = \frac{P_0 - d_0}{P_0}$$

$$p_1 = \frac{P_1 - d_1}{P_1}$$

$$p_2 = \frac{P_2 - d_2}{P_2}$$

$$p_3 = \frac{P_3 - d_3}{P_3}$$

$$p_4 = \frac{P_4 - d_4}{P_4}$$

d_0, d_1, d_2, d_3, d_4, represent the mean annual number of deaths at ages 0-1, 1-2, 2-3, 3-4, 4-5 respectively. For each of the first five years of life, therefore, the probability of living a year is obtained by dividing the number surviving at the end of the year by the number beginning the year.

The p_x values must now be calculated for the remaining years of life. Before proceeding, however, it would be well to explain certain terms:-

(1) l_x = the number who, out of a given number born, reach the precise age x.

(2) d_x = the number of deaths registered at any year of age x.

(3) P_x = the mean population at any year x.

(4) $m_x = \frac{d_x}{P_x}$ = the rate of mortality per unit at any year x.

(5) l_{x+1} = the number who reach the age x + 1, i.e., who become a year older than those reaching age x.

In the same way -

(6) $l_{x+\frac{1}{2}}$ = the number who reach half a year further on than x, and, as the deaths are assumed to be evenly distributed over the year

$$l_{x+\frac{1}{2}} = l_x - \tfrac{1}{2}d_x.$$

This/

This assumption, except for the first two years of life, causes only an infinitesimal error.
The following terms $l_{x+\frac{1}{2}}$, $\frac{1}{2}(l_x + l_{x+1})$, $l_x - \frac{1}{2}d_x$, & P_x . are therefore synonymous.

It has already been shown that the probability of living one year at any age x can be obtained by dividing the number of survivors at age x + 1 by the number who had started from age x.

$$\text{Therefore } p_x = \frac{l_{x+1}}{l_x}$$

$$= \frac{l_x - d_x}{l_x}$$

$$= \frac{(l_x - \frac{1}{2}d_x) - \frac{1}{2}d_x}{(l_x - \frac{1}{2}d_x) + \frac{1}{2}d_x}$$

$$= \frac{I - \dfrac{\frac{1}{2}d_x}{l_x - \frac{1}{2}d_x}}{I + \dfrac{\frac{1}{2}d_x}{l_x - \frac{1}{2}d_x}} = \frac{I - \dfrac{\frac{1}{2}d_x}{P_x}}{I + \dfrac{\frac{1}{2}d_x}{P_x}}$$

$$= \frac{2 - \dfrac{d_x}{P_x}}{2 + \dfrac{d_x}{P_x}} = \frac{2P_x - d_x}{2P_x + d_x}$$

$$= \frac{P_x - \frac{1}{2}d_x}{P_x + \frac{1}{2}d_x}$$

By this formula, the p_x values from p_5 to p_{87} have been calcu-lated. It was found, however, that the Graphic Method gave unsatisfactory results for the probabilities after p_{87} . This is due chiefly to the fact that the data at the higher ages both as to Census returns and as to registered deaths are very unreliable. Besides, towards the end of the curves, where the numbers are becoming smaller and smaller, an error, which would be of little importance at the part of the curves where/

where the numbers dealt with are larger, causes a very great discrepancy. It has been found advisable, therefore, to adopt a method giving a steadily decreasing value for p after p_{87}, using as a basis the values of p up to p_{87}. This is the method of differences of the logarithms of the probabilities. Here four known equidistant terms are selected, and so manipulated that a fifth equidistant term is obtained. For example, p_{57}, p_{67}, p_{77}, p_{87}, are known both for males and females.

For males:-

$p_{57} = .9689932$, $p_{67} = .9439142$, $p_{77} = .8805861$, $p_{87} = .7460970$.

The method of differences of the logarithms proceeds as follows

	1st Difference.	2nd Diff.	3rd Diff.
$\log p_{57} = \bar{1}.9863207$	$-\ .0113882$	$-\ .0187725$	$-\ .0230433$
$\log p_{67} = \bar{1}.9749325$	$-\ .0301607$	$-\ .0418158$	
$\log p_{77} = \bar{1}.9447718$	$-\ .0719765$		
$\log p_{87} = \bar{1}.8727953$			

the last differences of the three series are then added together.

$$
\begin{array}{r}
-\ .0230433 \\
-\ .0418158 \\
-\ .0719765 \\
\hline
-\ .1368356
\end{array}
$$

This result is then added to $\log p_{87}$

$$
\begin{array}{r}
\bar{1}.8727953 \\
-.1368356 \\
\hline
\bar{1}.7359597
\end{array}
$$

therefore $\log p_{97} = \bar{1}.7359597$

" $p_{97} = .5444521$

p_{97} being now known, p_{107} can be found in the same way to be .3245052.

Then on sectional paper and to a suitable scale the p_{87}, p_{97}, and p_{107} values are planned out, with a sufficient number of p_x values

values immediately preceding p_{87} to ensure a good sweep of the curve graphically representing the p_x values. From this curve the values of p intervening between p_{87} and p_{97}, and between p_{97} and p_{107}, can be readily calculated.

The same process has to be undergone for the female probabilities after p_{87}, taking as the basis the values for females of p_{57}, p_{67}, p_{77} and p_{87}.

Having obtained all the p_x values, the numbers in the l_x column are got in the following way. The number out of agiven number born, reaching the precise age x, is multi--plied by p_x i.e., the probability of living a full year for that year of age, and thus the number surviving to the age x + I is obtained. For example, the present Life Table for Scotland starts with 512, 139 males at birth;

therefore l_0 = 512,139.

Now p_0 i.e., the probability of living a full year for males at birth in Scotland has been calculated equal to .8565670.

Now $l_0 \times p_0 = l_1$

i.e., 512,139 $\times$ .8565670 = l_1

therefore 438,681 = l_1

In a like manner $l_2 = l_1 \times p_1$,

$l_3 = l_2 \times p_2$, and so on.

The next column is derived directly from the l_x column, and shows the mean number living in each year of life. This is called P_x, which had already been said to equal $\frac{1}{2}(l_x + l_{x+1})$. For the first year of life, however, the value of P calculated by the above method would be much too high. This is due to the fact that the deaths during the first year are very unevenly distributed, a very large proportion oc--curring in the earlier months. The average number of years lived, therefore, in the first year of life, i.e., P_0 have to be obtained by another method. What has been done is to find/

find the total deaths of males and females respectively under 6 months for the ten years, and also the total births. A proportionate number of deaths is then subtracted from the number at birth in each sex in the Life Table. Thus:-

512139 - 50060 = 462079 = mean number of years lived in the first year by males.

487861 - 38166 = 449695 = mean number of years lived in the first year by females.

All the P_x values having been obtained, the values in the Q_x column are directly derived from the P_x column, for $Q_x = P_x + P_{x+1} + P_{x+2} + P_{x+3} + \text{-----------} + P_{x+n}$, where x + n is the last age mentioned in the Life Table, i.e., the age at which the population becomes extinct.

The value of Q, therefore, at any age equals the sum of all the years lived at and above that age.

The values for the E_x (Expectation of life) column are then got from the l_x and Q_x columns.

for $E_x = \frac{Q_x}{l_x}$

For example, the aggregate number of years of life lived by 512,139 males born in Scotland reached 22,896,752 years. Now

$E_0 = \frac{Q_0}{l_0} = \frac{22,896,752}{512,139} = 44.71$ years.

The average number of years lived, therefore, by those males is 44.71, and this is what is understood as the expectation of life at birth for males in Scotland. The values of E_1, E_2, E_3, etc., are obtained in the same way.

P A R T I I.

ANALYSIS OF RESULTS OBTAINED ON THE FOREGOING PRINCIPLES FOR SCOTLAND. 1891 - 1900.

As has already been said, the object of a life-table is to get a standard by which to measure the vitality of a population, and to act as a means of comparing (1) the vitality of one population with that of another, as well as (2) that of the same population at different periods. When values and differences are expressed by exact numerical values, they are more easily comprehended and appeal more forcibly to the mind. It is agreed that for purposes of measurement and comparison the three points in a life-table that should absorb most attention are :- (a) The probability of living a year at each age. (b) The number of survivors, at the end of each year of life, out of a given number born. (c) The mean after-lifetime or expectation of life at each age. These three points have to be considered for both males and females.

(a) Probability at each age of living a year.

The probability at each age of living a year is dependent for each year on the lives and deaths of that year. It, therefore, is an expression of the conditions present in any year which may be under consideration, and is affected neither by past nor future lives and deaths. In Table V of those appended the probabilities for the different ages are given.

The following Table also gives the probabilities at several ages in Scotland, England and Wales, London and Brighton, for 1891 to 1900, and for Glasgow 1881-1890.

TABLE IX.

The probability of living one year at various ages in Scotland, England and Wales, London and Brighton, for 1891-1900, and in Glasgow 1881-1890.

AGE.	Males.				
	Scotland. 1891-1900.	England & Wales. 1891-1900.	London. 1891-1900.	Brighton. 1891-1900.	Glasgow 1881-1890.
0	.8565670	.82861	.81588	.8519402	.82531
5	.9934317	.99298	.99141	.9953582	.98417
10	.9968296	.99770	.99775	.9978542	.99455
15	.9961450	.99678	.99689	.9970452	.99347
20	.9937439	.99541	.99588	.9952317	.99219
25	.9927550	.99453	.99477	.9941232	.99187
35	.9906594	.99083	.98880	.9906840	.98831
45	.9853855	.98503	.98177	.9840304	.97920
55	.9720708	.97391	.96892	.9739014	.96469
65	.9508356	.95008	.94348	.9532772	.93675
75	.8943144	.89368	.88619	.9093900	.88267
	Females.				
0	.8821140	.85963	.84569	.8589370	.85318
5	.9932241	.99312	.99127	.9951877	.98511
10	.9963842	.99763	.99757	.9973425	.99497
15	.9953468	.99683	.99721	.9973245	.99370
20	.9943377	.99566	.99682	.9974127	.99180
25	.9934518	.99511	.99597	.9967650	.99028
35	.9905929	.99197	.99142	.9937594	.98738
45	.9881373	.98833	.98657	.9891837	.98293
55	.9789915	.97938	.97673	.9819252	.97085
65	.9567557	.95814	.95562	.9650290	.94646
75	.9147546	.90676	.90371	.9190734	.90403

In each of the above tables the probability of living a year at birth is lower than at any of the succeeding ages quoted. The first point to arrest attention, however, is the value expressing the probability of living a year at birth both for males and females in Scotland, as compared with England and Wales, London, Brighton, and Glasgow. The ques- -tion arises as to the reason of the high probability in Scotland as a whole. Now, the ruling factor in fixing the probability for/

for any year is the death rate of that year, a high mortality causing a low probability, and conversely, a low mortality a high probability. An inquiry into the infantile mortality of Scotland for the ten years 1881-1900 showed that the figures for the total infantile births and deaths for that period were as follows:-

Registered Births in Scotland during 1891-1900,	(Males (Females	655561 624483	Total 1,280,044.
Infantile deaths in Scotland during 1891-1900,	(Males (Females	91,802 71,960	Total 163,762.
Therefore Infantile Mortality in Scotland 1891-1900,	(Males (Females	140.03 115.23	p.1,000 reg. M.bir. " " F. "
Therefore General Infantile mortality in Scotland 1891 to 1900.	127.93 p.1,000 regd. male and female births.		

The figures for England and Wales were found to be as follows:-

Registered Births in England & Wales during 1891-1900,	(Males (Females	4,657,846 4,497,365	Total 9,155,211
Infantile deaths in England & Wales during 1891-1900,	(Males (Females	781,475 622,244	Total 1,403,719.
Therefore the Infantile mort-ality in England & Wales 1891-1900,	) Males)Females	167.77 138.35	p.1,000 reg. M. bir. " " F. "
Therefore general Infantile Mort-ality in England & Wales 1891 to 1900,	) 153.32 p.1,000 registered male and female births.		

It will be seen from the above, that the Male Infantile Mortality in England and Wales for the decennium 1891-1900 was 27.74 per 1,000 registered Male births higher, and the Female Infantile Mortality 23.12 per 1,000 registered female births higher than in Scotland.

The general infantile mortality in England and Wales for the decennium was 25.39 per 1,000 registered male and female births higher than in Scotland.

The/

The following shows the great importance of the comparatively low infantile mortality in Scotland,-

196,256 = number of infantile deaths that would have occurred in Scotland ~~in Scotland~~ in 1891 to 1900, if the same rate had held as in England.

163,762 = actual number of infantile deaths in Scotland 1891-1900.

----

therefore 32,494 = number of infantile lives saved in Scotland as compared with England 1891-1900.

therefore 3249.4 = mean annual number saved during the first year of life.

Again,

1,403,719 = actual number of infantile deaths in England 1891-1900.

1,171,226 = number to which infantile deaths would have been reduced in England 1891-1900, if the same infantile death-rate had held as in Scotland.

----

therefore 232,493 = number of infantile lives that would have been saved in England 1891-1900, if the same rate had held as in Scotland.

therefore 23,249.3 = mean annual excess of infantile deaths in England as compared with Scotland.

The above comparison is exceedingly favourable to Scotland, and the causes tending to produce such a pronounced difference are worthy of careful study. It is well known that a large proportion of the death-rate during the first year of life is due to infantile Diarrhoea, which again is greatly increased by high temperature and deficient rainfall extending over a period. Whether it is due to conditions outwith the control of the people, such as temperature, rainfall, etc., or to con--ditions within their control, such as feeding, housing, sanita--tion generally, etc., would afford interesting study, but con--sideration of the question cannot be undertaken here.

It has already been said that in the detailed report of the Registrar-General for Scotland in 1873 is contained a Life/

Life Table by W. Robertson, M.D., based on the Census enumeration of 1871, and on the registered deaths of that year. Now the 1871 Table is also remarkable for the very high probability at birth of living a year, both for males and females,- the probability for males being very slightly higher than in the present table, and for females slightly lower. This result is borne out by the infantile mortality of 1871, the male infantile mortality of that year being about 1 per 1,000 less, and the female about 5.6 per 1,000 more than in 1891-1900. Scotland then by comparison has enjoyed a favourable infantile mortality, and the decennium 1891-1900 has not been exceptional.

On comparing the probability at birth with succeeding probabilities it can be seen how low it is even for Scotland. A child's hold upon life during its first year, and especially during the earlier months of that year, is very feeble. By the time the child has reached the end of its first year, its hold has greatly strengthened, and its chance of living a year gradually increases with each year of age, until it reaches eleven years, when its maximum vitality is reahhed. This is true for males and females alike. Thereafter, there is a general decline in the p_x values from year to year. This decline might be said to be steady, were it not that after p_{24} in Males there is a slight rise to p_{26}, from which point the values steadily decrease. This irregularity in the p_x values for males in Scotland has been investigated, and the results will be given later.

If the probability of living a year of a man of eighty-one years of age be compared with that of a male at birth in Scotland, it is seen that the former's chances are slightly greater. In the same way, if the chances of a woman/

woman of seventy-nine and of a female at birth be compared, the odds are seen to be slightly in favour of the woman. The p_x values for females in Scotland are as a rule slightly higher than for males, the following being the exceptions, p_3 to p_{16}, and p_{28} to p_{35}. These exceptions are possibly due to the difference in the age-incidence of Phthisis and other Tuberculous diseases in Males and Females, but this point will receive more attention further on.

The probability at birth, then, both for Males and Females in Scotland has been shown in the foregoing table to be higher than in England, London, Brighton, or Glasgow. Of the ages quoted, the probability is lower in Scotland than in England at 5, 10, 15, 20, 25, 35, and 55 years for Males, and for females in Scotland the probability is lower than in England at ages 10, 15, 20, 25, 35, 45, 55, and 65 years.

So far as the probability of life at birth is con--cerned, London is lowest of the group, but presents higher probabilities than even England at ages 10, 15, 20, and 25 years for males, and at ages 15, 20, and 25 for females.

Brighton justifies its character as a health resort, the probabilies being higher than in Scotland at all the ages quoted, with the exception of "at birth." The probabilities in Glasgow at all the ages quoted are lower than those of Scotland as a whole, and this is what might be expected from a large manufacturing centre.

Figs. V and VI graphically represent the probabili--ties of life in the Life Table of 1891-1900, and a comparison of these with the probabilities in the Life Table of 1871 shows that the present probabilities are higher from p_1 to p_{52} for males, and from p_0 to p_{51} for females. Thereafter the values are slightly lower by the present Life Table. In making/

making any deductions from Dr. Robertson's table, however, it must be remembered that the basis on which it was con-structed is very narrow, being in fact the figures of one year, which may have been exceptional. Farr himself was dissatisfied with his English Life Table No. 1, because it was founded on the census returns and deaths of one year only, viz., 1841. He therefore proceeded to calculate his English Life Table No. 2 on the census returns of 1831 and 1841, and the deaths of seven years 1838-1844.

(b) The Number of Survivors at the End of each Year.

The second point for consideration is the number of survivors at the end of each year of life out of a given number born. It is wholly dependent on the conditions affecting the past, the number of survivors being greater or fewer, in proportion as the conditions had been more or less favourable.

In Table V appended will be seen the number of survivors at each year of age out of 1,000,000 males, and 1,000,000 females born in Scotland.

In the following tables X and XI the survivors at various ages in Scotland 1891-1900 are compared with those of England and Wales, London, and Brighton for the same decennium and of Glasgow 1881-1890.

TABLE X.

Male Survivors at Various Ages out of 100,000 born.

Age.	Scotland. 1891-1900.	England & Wales 1891-1900.	London 1891-1900.	Brighton 1891 - 1900.	Glasgow 1881 - 1890.
0	100,000	100,000	100,000	100,000	100,000
1	85,656	82,861	81,588	83,194	82,531
2	81,128	78,467	76,229	79,212	74,044
3	79,332	76,836	74,123	77,503	70,422
4	78,281	75,826	72,793	76,472	68,231
5	77,550	75,093	71,898	75,790	66,870
10	75,675	73,524	70,152	74,550	63,550
15	74,481	72,631	69,295	73,785	61,799
25	70,127	69,502	66,554	70,551	57,288
35	64,895	64,895	61,742	65,732	52,148
45	57,822	57,807	53,471	58,260	44,653
55	47,637	47,547	42,223	47,535	34,061
65	33,033	33,281	27,764	33,836	31,211
75	16,091	15,778	12,198	17,655	8,711
85	3,651	3,103	2,216	4,012	1,641

TABLE XI.

Female Survivors at Various Ages out of 100,000 born.

AGE.	Scotland 1891-1900.	England & Wales 1891-1900.	London 1891-1900.	Brighton 1891 - 1900.	Glasgow 1881 - 1890.
0	100,000	100,000	100,000	100,000	100,000
1	88,211	85,963	84,569	85,894	85,318
2	83,776	81,717	79,415	81,775	77,188
3	81,943	80,074	77,269	80,148	73,566
4	80,842	79,008	75,888	79,173	71,424
5	80,058	78,255	74,936	78,656	69,992
10	77,995	76,613	73,049	77,272	66,865
15	76,600	75,661	72,150	76,272	65,109
25	72,426	72,591	69,875	74,273	60,108
35	66,917	68,272	65,944	71,045	53,802
45	60,275	62,063	59,195	65,449	46,597
55	51,647	53,297	49,721	56,984	37,441
65	38,341	39,897	36,172	44,767	25,156
75	20,900	21,084	18,592	25,837	12,074
85	5,581	4,999	4,235	6,442	3,123

The males reaching 1 year of age in Scotland out of 100,000 born exceed those in England by 2795. This gives Scotland/

Scotland an advantage which is slowly lessened, until at age 35 the numbers surviving in both Scotland and England are exactly the same, viz., 64895 males. Very much the same can be said with regard to the female survivors in Scotland and England. The advantage here which Scotland gets in the first year is 2248, but this had disappeared before the end of the 25th year, when the female survivors in England slightly exceed those in Scotland. As will be shown later on, this gradual approximation of the numbers of male and female survivors in the two countries is probably due to an excessive death-rate in Scotland from Phthisis and other Tuberculous Diseases as compared with England.

From age 35 onwards in males the difference in the number of survivors in Scotland and England at each age is remarkably small, the difference in the female survivors at these ages being a little more. In Scotland one-half of the males are dead before reaching the 54th year, and one-half of the females before reaching the 57th year.

London has fewer survivors at every age both for males and females, - while Brighton has fewer in the earlier years, the deficiency being mostly due to its greater infantile mortal--ity, but from the 25th year the male survivors in Brighton at each age exceed those in Scotland, and from the 17th year the Brighton female survivors exceed those in Scotland.

Glasgow has a smaller number of survivors at every age than Scotland as a whole. As might be expected, it compares unfavourably. A life table for Glasgow constructed on the figures of 1891-1900 would probably show marked improvement, as the death-rate in Glasgow for 1891-1900 was 21.528 per 1,000 as compared with 24.220 in 1881-90.

Dr. Robertson's table begins with 513,950 males and 486,050 females/

females in 1,000,000 at birth. That is to say, for every 1,000 female births in 1871 there were 1057 male births. The present table begins with 512,139 males and 487,861 females in 1,000,000 at birth. For every 1,000 female births, therefore, in 1891-1900 there were 1049 male births.

Although there are more males at the beginning of the 1871 table, the survivors at all ages from 2 onwards to eighty-nine are greater by the 1891-1900 table. The females are slightly less at the beginning of the 1871 table, but this disparity in the number of survivors is increased at almost all ages in favour of the present table.

It has been pointed out that the probabilities of life for males from p_{53}, and for females from p_{52}, onwards, are slightly greater by the 1871 table, which should mean of course that the death-rate of the year 1871 was lower from age 52 in females and 53 in males than the death-rate of the ten years 1891-1900. That the number of survivors in the present table is greater at practically all ages is due to the fact that the number saved up to 52 years of age in females and 53 in males is so very much greater than in the 1871 table, that the people of Scotland can now support a slightly heavier death-rate after these ages, and still have even at the higher ages a preponderance of survivors.

(c) The Mean After-lifetime or Expectation of Life at each Age

The third point, i.e., the Mean after-lifetime depends upon the aggregate number of years lived by a population entering on any age, at and after that age, and expresses the average number of years lived from that age by the members of the population. Its duration may be taken as a measure of the conditions, as to their being favourable or unfavourable, under which the people have been living during the years following any age. If the/

the conditions are unfavourable the death-rate is increased and the expectation of life is lowered. The best illustration of this is afforded during the first five years of life. For example, in Scotland the life-table begins with 512,139 male children at birth. The aggregate number of years lived by these is 22,896,752. Therefore the mean after-lifetime at birth =

$$\frac{22,896,752}{512,139} = 44.71 \text{ years for males.}$$

Now, in the first year of life the death-rate is very high so that the number beginning the second year is 438,681 males. The grand total of years lived from the beginning of the second year onwards is 22,434,673, and this number has to be divided equally among the 438,681 males. Therefore the mean after-lifetime for males entering on the second year = $\frac{22,434,673}{438,681}$ = 51.14 years. Comparing the fraction $\frac{22,896,752}{512,139}$ with $\frac{22,434,673}{438,681}$ it is seen that the denominator of the second as compared with that of the first is proportionately much more reduced than the numerator of the second as compared with that of the first. Thus the quotient is greater in the second case. The expectation of life at birth is therefore lowered by the excessive infantile mortality, but, as this unfavourable period passes, the expectation of life goes on increasing until it reaches a maximum at three years of age, when for males it is 53.16 years, and for females 54.75 years. In both cases after the third year it steadily declines, keeping higher, however, for females at all ages than for males.

The Expectation of life at each age in Scotland for males and females is shown in column E_x of tables III and IV appended.

In the following tables XII and XIII is given the expectation of life at different ages in Scotland, England and Wales, London, Brighton, and Glasgow.

TABLE/

TABLE XII.

Expectation of Life among Males.

Ages	Scotland 1891-1900.	England & Wales 1891-1900.	London. 1891-1900.	Brighton 1891-1900.	Glasgow 1881-1890.
0	44.71	44.17	40.98	44.92	35.18
5	52.36	53.50	51.60	53.94	46.97
10	48.60	49.60	47.84	49.80	44.32
15	44.34	45.18	43.40	45.29	40.51
20	40.43	41.01	39.13	41.09	36.90
25	36.75	36.97	34.96	37.12	33.29
35	29.30	29.22	27.25	29.45	26.06
45	22.24	22.15	20.65	22.54	19.54
55	15.85	15.78	14.76	16.44	13.99
65	10.57	10.30	9.76	11.01	9.38
75	6.38	6.13	5.91	6.49	5.96
85	3.38	3.49	3.48	3.01	3.75

TABLE XIII.

Expectation of Life among Females.

Ages	Scotland 1891-1900.	England & Wales 1891-1900.	London 1891-1900.	Brighton. 1891-1900.	Glasgow. 1881-1890.
0	47.47	47.82	45.33	50.19	37.70
5	54.02	55.82	55.12	58.52	48.27
10	50.39	51.97	51.49	54.53	45.44
15	46.26	47.59	47.10	50.21	41.59
20	42.41	43.44	42.77	45.82	38.00
25	38.63	39.38	38.46	41.42	34.60
35	31.37	31.53	30.42	33.06	28.06
45	24.27	24.16	23.29	25.42	21.61
55	17.42	17.26	16.72	18.41	15.60
65	11.60	11.26	11.01	11.98	10.69
75	7.05	6.70	6.57	6.91	6.97
85	3.75	3.79	3.79	3.36	4.32

The Expectation of Life of Males at birth in Scotland exceeds that in England by .54 of a year. Of the other ages quoted England has a greater Expectation of Life at ages 5, 10, 15, 20, 25, and 85. In Scotland, however, the total number of years lived at and above each of these ages is greater than in England, so that the lower expectation of life in Scotland at these ages is greatly due to a larger number of survivors , among whom the aggregate number of years lived have to be divided. It has already been pointed out how a high mortality during any year lowers the expectation of life for the beginning of that year.

The Expectation of Life of Males in London is lower at all the ages except at 85. In Brighton on the other hand it is higher at all the ages except at 85. Glasgow shows the lowest values at all the ages except at 85, at which age the Expectation of Life in Glasgow for both Males and Females is higher than in any of the places quoted.

The Expectation of Life of Females in England is higher on to age 35, and again at 85. From 45 to 75 Scotland has the higher values. Again the lower values in Scotland at the early ages are greatly due to a larger number of survivors.

As a large City, London compares very favourably with Scotland in the Expectation of Life among its females at the different ages; while Brighton has higher values than Scotland for the Expectation of Life of Females at all ages mentioned except 75 and 85.

In Glasgow the Expectation of Life of Females is very low as compared with the other places, - at 85 however it is higher than for any of the other places.

From the above tables it will be seen that the general rule is that at all ages females enjoy a higher expectation of life than males.

Figs. VII and VIII graphically represent the expectation of life for males and females in Scotland at the different ages both for the Life-Table of 1871 and that of 1891-1900, the years of age being represented along the base line, and the expectations/

expectations at the different ages being represented by the height of the ordinates. This vividly demonstrates the immense advantage which the present enjoys over the past. The Expectation of Life at birth by Dr. Robertson's Table is for males 39.79 years, and for females 42.05 years. The corresponding figures in the Table of 1891-1900 are 44.71 for males, and 47.47 for females. That is to say, males now have on an average 4.92 years, and females 5.42 years, more of life than by the table of 1871. Up to 43 years of age the Expectation of Life for males is greater at every age by the present table than by Dr. Robertson's,- at 44 the expectations exactly coincide, being 22.92 years. From 45 onwards in males the old table presents slightly higher values for expectation of life.

Females by the present table have a higher expectation of life than by the old up to 41 years of age,- at 42 the values practically coincide,- thereafter the females in the old table have a very slightly higher expectation of life at each age. It should be noted at this point however, that both for males and females in the present table the number of years lived in and above each year of age, viz., Q_x is greater at every age than by the 1871 Table, and, if in the higher ages the Expec--tation of Life, viz., E_x is greater by the old than by the new table, this is due to a larger number of survivors l_x at all ages in the new table. To still further explain this point:-

$$E_x = \frac{Q_x}{l_x}$$

Now, Q_x at all ages by the new table is much increased, but l_x is also much increased at all ages by the new table, and, at the higher ages is proportionately more increased than Q_x Therefore, the values of E_x at the higher ages in the new table are lessened.

The English Life Tables present a very similar case. It was found/

found that the 1881-1890 table for England showed higher expectations than the 1871-1880 table up to 44 years, after which the latter had slightly higher values.

Dr. Hayward, however, showed that when the figures of 1871 to 1880, 1881-1890, and 1891-1900 were calculated by strictly comparably methods, the Expectations of Life even at the higher ages in 1881-1890, and more so in 1891-1900, were more favourable than in 1871-1880.

If a strict investigation were instituted into the figures of 1871, and those of 1891-1900 for Scotland, a like result would in all probability be arrived at.

In so far then as a table with such a basis can be accepted as reliable, that of 1871 may be taken as a measure of the vitality of the people of Scotland before the Public Health Acts had produced their effect. The comparison of the present with the old table bears eloquent testimony to the greatly increased vitality of the people at the present time. Such figures seem wonderful, when it is considered to what an extent the urbanization of the population of Scotland has gone on since 1871, and they also render it hard to believe that there is any real foundation for the cry about Physical Degeneration of the Race.

PART 111

INQUIRY INTO POINTS SUGGESTED BY THE FOREGOING, when compared with Life Tables for other Places and Periods.

It will be noticed that the graphic curve of distribution of deaths of males in Scotland (fig. 111) presents two well-marked crests, one at age-period 20-25, and the other at 65-75.

Now, a crest at age-period 20-25 is quite exceptional, what usually happens being a general rise in the curve from the 10-15 period to the 65-75 period. It was found that very much the same irregularity existed in the curve distributing the deaths of females in Scotland for some years before and after 1870, but in 1891-1900 the crest intervening between the age-periods 10-15 and 65-75 had disappeared in the case of deaths of females.

An attempt at the elucidation of this irregularity has occupied a considerable amount of time. This unusual feature is due to an excess of deaths among males in Scotland at the age-period 20-25, as compared with 25-35, so that the parallelogram representing the deaths of males from all causes at 20-25 rises above that representing the deaths at 25 to 35, the additional area above being equivalent to an excess of 1459 deaths at 20-25. It is this excess which causes the p_x values for males to decline to such an extent towards p_{24}, from which point there is a rise to p_{26}, the p_x values thereafter forming a regularly decreasing series.

How to explain this excess of deaths among males at 20-25 in Scotland was the problem. In the first place, it is to be noted that the excess extended over the whole decennium 1891-1900. Besides, this state of affairs is found to extend over a considerable period, for in 1871, on the figures of which year Dr. Robertson calculated his table, and for some years before and after 1871 the number of deaths of Males at 20-25 is not exceeded in any quinquennium until 60-65. The crest at 20-25 in those years was therefore even more prominent than it is now. For years following 1871 this prominence has been gradually declining, so that the number of deaths at 20-25 is found to be exceeded at 55-60, then at 50-55, then 45-50, then 40-45, then 35-40 as in 1891-1900. If the table of 1871 had been done by the graphic method the values of the probabilities would also have reached a low point about p_{24}, and then for some years the values would have increased, the very unfavourable period 20-25 having been passed.

Above, it has been shown that the prominence of the crest of the general death curve for males in Scotland at 20-25 has been gradually decreasing. This decreased prominence of deaths at 20-25 in males is due to the fact that the annual number of deaths at 20-25 has remained practically the same since 1870, although the male population up to 1900 had increased fully half a million. The deaths at the quinquennia 55-60 and 60-65, on the other hand, have increased very much in proportion to the increase in population. The following table will illustrate this:-

Deaths of Males in Scotland.

Year.	Age-Period. 20-25.	Age-period. 55-60	Age-period. 60-65.
1870.	1384	1360	1611
1900.	1458	2129	2432

Had the deaths at 20-25 increased in proportion to the population, then in 1900 they would ~~had~~ have numbered about 1840/

1840. The saving in lives for ~~1890~~ 1900 as compared with 1870 is therefore about 380 at this one age-period.

Very much the same can be made out from a study of the deaths of females in Scotland from 1870 onwards. Thus:-

Deaths of Females in Scotland.

Year.	Age-Period. 20-25.	Age-period. 55-60.	Age-Period. 60-65.
1870.	1399	1315	1708
1900.	1239	2125	2445

The figures for females are even more striking than for males at 20-25, the deaths of females at this age-period being actually fewer in 1900 than in 1870, although the female population had increased fully half-a- million. Had the deaths of females at 20-25 increased in proportion to the increase in population, they would have numbered about 1860. The saving at this period therefore represents about 620 lives in the year 1900 as compared with 1870.

In 1870 the deaths of females at 20-25 are not exceeded at any quinquennium until 60-65. This state of affairs undergoes the same gradual change as has been pointed out for males, only the change has gone further, so that for the decennium 1891 to 1900 the general death-curve for females ascends from the period 10-15 to 65-75, there being no intervening crest.

The curve for deaths of females in Scotland had, therefore, more closely approximated to that for female deaths in England, than has the curve for deaths of males in Scotland to that in England. This process is in a transition period, and will doubtless go on.

A cause operating for a good many years had then to be sought for/

for, in order to explain this marked decrease in the death-rate among males and females in Scotland at 20-25. This period may be taken to represent more or less the state of affairs in adjacent quinquennia. It was found that a large proportion of the deaths at these ages is due to Phthisis and other tuberculous diseases. The deaths from these diseases in 1870 and 1900 are given below for three quinquennia:-

Deaths of Males in Scotland from Phthisis and other Tuberculous Diseases.

Year.	Age-Period. 20-25	Age-Period. 55-60	Age-Period. 60-65.
1870.	727	148	121
1900.	663	171	124

The deaths at 20-25 in 1900 have actually decreased, although the male population had increased fully half-a-million. Had the deaths from all Tuberculous Diseases gone on increasing proportionately to the population, there would have been fully 960 deaths of males at 20-25. There was a saving, therefore, in 1900, as compared with 1870, of about 300 lives.

It has already been shown that the total saving in male lives at the age-period 20-25 in Scotland in 1900 as compared with 1870 was 380, and now it is shown that 300 out of the 380 ~~who~~ were saved by a reduction in the death-rate from Phthisis and other Tuberculous Diseases in 1900 as compared with 1870.

For females the coresponding figures are:-

Deaths of Females in Scotland from Phthisis and other Tuberculous Diseases.

Year.	Age-Period. 20-25.	Age-Period. 55-60	Age-Period. 60-65.
1870.	787	145	122
1900.	577	108	72.

In/

In females there has been a more marked decrease in the death-rate from the above diseases than among males. The deaths at all the three periods are markedly less in 1900, al- -though the female population had increased so much. In pro- -portion to the increase in population the deaths in the age-group 20-25 in 1900 would have been about 1040. Therefore about 460 females at 20-25 are saved by the decrease in the death-rate from Phthisis and other Tuberculous diseases in 1900, as compared with 1870. The propor- -tional decrease in deaths from all causes among females at 20-25 in 1900 was shown to be 620 and now it is shown that 460 out of the 620 are saved by a lessened mortality from Phthisis, and other Tuberculous diseases. The saving, therefore, in the general death-rate of males and females at 20-25 since 1870 is mostly accounted for by the marked saving effected in the deaths from tuberculous diseases at that ~~period~~ age-group. What has been said of the period 20-25 is also largely true of the quinquennia 15 to 20 and 25-30.

The deaths among Males in Scotland from phthisis and other tuberculous diseases were abstracted from the Registrar Geheral's return for the ten years 1891-1900, the total deaths for the different age-periods being shown in the following table:-

Total Deaths from Phthisis and other Tuberculous diseases among Males in Scotland 1891-1900.

...od.	0-5	5-10	10-15	15-20	20-25	25-35	35-45	45-55	55-65	65-75	75-85
...s, ...900.	10826	2616	2053	4863	6072	8947	6704	4463	2551	909	154

In figure IX in which the above deaths from all tuberculous diseases have been charted out and distributed according/

according to the method already described, the parallelogram representing the deaths at 20-25 towers above that at 25-35 the excess amounting to **1598** deaths. These more than account for the 1459 deaths, that form the excess of deaths already mentioned from all causes at 20-25 over 25-35 (see also figure I).

The deaths from all causes and from Phthisis and other tuberculous diseases have been abstracted from the Registrar General's returns in a like manner for England and Wales with the following result:-

Total Deaths from all causes among Males in England and Wales during the decennium 1891-1900.

[illegible].	0-5	5-10	10-15	15-20	20-25	25-35	35-45	45-55	55-65	65-75	75-85
[illegible],00	1134786	73950	40154	58043	68384	153545	202280	243721	291430	324081	225973

85 & Above
48876.

If the above deaths were represented by parallelo- -grams in the same way as deaths of males from all causes in Scotland (as in fig. I) the area of the parallelogram for the age period 25-35 above that for the age-period 20-25 would be equivalent to an excess of 16577 deaths.

Following this still further, the deaths from all tuberculous diseases among males in England for the decennium 1891-1900 were tabulated with the following result:-

Total/

Total deaths from Phthisis and other Tuberculous diseases among Males in England and Wales during the decennium 1891-1900.

.	0-5	5-10	10-15	15-20	20-25	25-35	35-45	45-55	55-65	65-75	75-85
00	78654	12091	8538	18900	28416	57746	57203	42399	23081	7852	1021

Above 85.
60

These deaths being graphically represented in the same way as the deaths from tuberculous diseases in Scotland, it is found that the parallelogram representing the age-period 25-35 rises above that representing the age-period 20-25. The experience of Scotland then at these two age-periods, both with regard to deaths of males from all causes and from Phthisis and other tuberculous diseases, is opposed to that of England, the conclusion being that the excess of deaths of males at 20-25 in Scotland is largely due to an excessive mortality from Phthisis and other tuberculous diseases at that age-period.

This led to a consideration of the proportion which deaths from Phthisis and other tuberculous diseases formed of deaths from all causes at the different age-periods in Scotland, as compared with England and Wales. This has been shown for both males and females in the following tables, in which are given (1) the deaths from all causes, (II) the deaths from all tuberculous diseases, and (III) the proportion which (II) forms of (1).

Males/

Males in Scotland 1891-1900.

Age-Period.	0-5	5-10	10-15	15-20	20-25	25-35	35-45	45-55	55-65	65-75	75-85	Above 85.
I. Total Deaths, ...	143414	12053	7425	11341	13061	23203	26232	32432	40251	41541	29919	8464
II. Deaths from all Tuberculous diseases,	10826	2616	2055	4863	6072	8947	6704	4463	2551	909	154	10
III. Percentage of I which II forms, ...	7.55	21.7	27.6	42.8	46.4	38.5	24.8	13.7	6.3	2.1	0.5	0.1

Males in England 1891-1900.

I. Total deaths, ...	1134786	73950	40154	58043	68384	153545	202280	343724	291430	324081	225,978	48876
II. Deaths from all Tuberculous diseases,	78654	12091	8538	18900	28416	57746	57203	42399	23081	7852	1021	60
III. Percentage of I which II forms, ...	6.9	16.3	21.2	32.5	41.5	37.6	28.2	17.3	7.9	2.4	0.45	0.12

Females in Scotland, 1891-1900.

Age-period.	0-5	5-10	10-15	15-20	20-25	25-35	35-45	45-55	55-65	65-75	75-85	Above 85.
I. Total deaths, ...	121277	12563	8187	11191	12328	25997	26046	29448	40519	49174	41286	14508
II. Deaths from all Tuberculous dis- -eases, ...	9101	3037	3559	6005	5799	10304	6686	3183	1705	699	161	13
III. Percentage of I which II forms, ..	7.5	24.1	43.4	53.6	47.0	39.6	25.6	10.8	4.2	1.4	0.3	0.09

Females in England 1891-1900.

I. Total deaths, ..	962126	75381	42110	57075	67560	152699	180127	206112	271758	346021	273,591	75589
II. Deaths from all Tuberculous dis- -eases, ...	64067	12832	13425	24214	27080	52374	42513	24515	12842	5164	953	66
III. Percentage of I which II forms,	6.6	17.0	31.8	42.4	40.1	34.3	23.6	11.8	4.7	1.5	0.35	0.09

It should here be pointed out that the method of comparing the percentage which the deaths from tuberculous diseases form of the deaths from all causes is not entirely reliable, for, even although the deaths from tuberculous diseases remain the same, if there is a shrinkage of deaths from all causes, or an increase, the proportion of deaths from tuberculous diseases to deaths from all causes is affected in the opposite direction. However, the differances in favour of England are so great as to strongly point to a much greater mortality in Scotland from tuberculous diseases.

The above tables show that the deaths of Males in Scotland from all tuberculous diseases range from 7.55 per cent. of total deaths at the age-period 0-5 to a maximum of 46.4 per cent at the 20-25 age-period, after which the percent-age declines until at 65-75 it is only 2.1, and subsequently it is even smaller.

In England the range for Males is from 6.9 per cent at 0-5 to 41.5 at 20-25. The proportion of deaths of males from tuberculous diseases to total deaths up to the age-period 25-35 is much greater in Scotland than in England, the greatest difference being 10.3 per cent. at 15-20. After the period 25-35 there is a slight percentage in favour of Scotland.

Among Females in Scotland the deaths due to tubercu-lous diseases from age-period 5-10 to 25-35 are more numerous than among Males in Scotland, after which the Males show most deaths. In the first five years of life the effect on both sexes is practically the same. From five on to thirty-eight years of age females suffer more heavily than males,- thereafter there is a slight balance in favour of females. ~~It will be~~ noticed that among females in Scotland the percentage of deaths from tuberculous diseases reaches its highest point, viz., 53.6 per cent. of total deaths at the age-period 15-20, whereas among males the highest percentage of deaths is attained at

20/25/

20-25.

From what has been said and also from figs. IX and X, it will be seen that the curve distributing the deaths of females in Scotland from tuberculous diseases is maintained at a generally higher level from five years of age on to 38 than that distributing the deaths of males. The latter, however, presents a much more pronounced crest at 20-25, and it is the sudden effect produced by this on the general death-curve which causes the p_x values to reach a lower point at p_{24} than for some years following.

The higher mortality from tuberculous diseases among females at 15-20 can in great part be explained by the very general disturbance and lowered vitality caused by the establishment of certain physiological functions about this age.

A comparison of the deaths of males in Scotland and England from all tuberculous diseases has been shown to be very unfavourable to Scotland. Still more unfavourably do the deaths of females from tuberculous diseases in Scotland compare with those of females in England.

As can be seen from the above tables the proportion of deaths from tuberculous diseases among females in Scotland ranges from 7.5 per cent. of total deaths at age-period 0-5 to 53.6 per cent. at age-period 15-20. In England the range is from 6.5 per cent. of total deaths to 42.4 per cent. at the same age-periods. Scotland shows a far greater percentage of deaths among females from tuberculous diseases right on to age-period 35-45, after which there is a very slight percentage in favour of Scotland.

Scotland then, both as regards males and females, up to the age-period 35-45 is more severely affected by tuberculous diseases than England, and, with such pronounced differences in the deaths from tuberculous diseases, irregularities in the curve representing/

representing the deaths from all causes are what might be expected

It is true that Scotland presents a larger number of survivors than England out of a given number born, at each year of life up to the 35th year in males, and to about the 25th year in females, but this is entirely due to the immense ~~handicap~~ advantage Scotland receives during the first year of life. So much less is the Infantile mortality in Scotland than in England, that, as compared with England, there are saved during the first year of life, out of 1,000,000 of each sex at birth 27,950 additional males, and 22,480 additional females, who thus enter on their second year of life.

The gap in the number of survivors at each age is grad--ually lessened until the numbers for England are level with those for Scotland, at age 35 in the case of males, and about age 25 in the case of females, although the total years lived up to this period are of course greater in Scotland.

The gradual lessening of the advantage gained by Scotland at the beginning of life, is readily explained by the greater prevalence of tuberculous diseases. Could the mortality from these diseases be reduced even to the same level as in England, then Scotland at every age would present a greater number of survivors out of a given number born, even although the pro--babilities of life in the two countries from p_1 onwards might remain much the same. The mean after-lifetime at birth would be much enhanced, as the grand aggregate of years lived would be greatly increased. The great advantage at any age from one year onwards would be seen in the number of survivors and in the total years lived by those entering on the age.

The mean after-lifetime from E_1 onwards might be much the same in Scotland and England, as, although the total years lived at, and beyond, any age in Scotland would be greater than in/

in England, they would require to be divided among a larger number of survivors.

Lives saved at an early period have a much greater effect in increasing the mean after-lifetime at birth than those saved at a later period of life, as it is possible for the former to add a greater number of years to the aggregate number of years lived than the latter can be expected to do. The pressing question then for those interested in Public Health in Scotland is how to improve the death-rate from Phthisis and other tuberculous diseases, and so maintain the advantage derived from a comparatively low infantile mortality. Not that the infantile mortality in Scotland is quite satisfactory, as can be shown from that of several of the large towns during the ten years 1892-1901, e. g.,

<u>1892-1901</u>.

Glasgow, ...	149	per 1,000 regd. births.
Edinburgh, ...	143	" "
Dundee, ...	177	" "
Aberdeen, ...	146	" "

These all compare very badly with Scotland taken as a whole, which for the decennium 1891-1900 shows a general infantile mortality of 127.93 per 1,000 registered male and female births. It may be expected that the large towns under improved hygienic conditions will show a marked decrease in infantile mortality. It should be remembered, too, that if the general death-rate from tuberculous diseases could be lowered, the first year of life, which has by far the largest number of deaths from these diseases, might be confidently expected to participate in the improvement, and thus the infantile mortality would be still further lowered.

The problem of how to decrease the death-rate from tuberculous diseases is worthy the best efforts of private individuals/

individuals and also of communities. That such numbers, as have been shown, especially of those in the earliest years of life, of adolescents, and of young adults, should succumb yearly, is a national calamity. If, as has been often said, the lives of the people form the most valuable asset of the state, might it not prove a profitable investment for the state to grapple with tuberculous diseases, which have been shown to be not only curable but preventable. At present all the outlay necessary to rear and educate quite a large proportion of the population gives no return, and many young and valuable lives are lost to the state at the very beginning of their most productive and useful period.

At a time when the people have awakened to a sense of their duty with regard to tuberculous diseases, it seems desirable that the effects of these should be placed on an exact basis for future comparison. The present ravages, however, are apt to bulk so largely in people's view that they forget the great improvement (probably about 50 per cent.) which has occurred in the death-rate from tuberculous diseases during the last sixty years. This gradual decrease in mortality has been most marked since the passing of the Public Health Acts, and has gone on alongside the gradually improving con-ditions of the working classes as to labour, housing, food, and education. A great impetus in the right direction was given by Koch's discovery in 1882 of the Tubercle Bacillus as the cause of tuberculous diseases. This discovery has enabled the treatment of these diseases, and also the preventive measures, to be placed on a thoroughly scientific basis.

In any comparison, therefore, of the future with the present statistics with regard to tuberculous diseases, it should be remembered that the comparison is with a time when already/

already the effects of these diseases have been greatly ameliorated.

Probably the best way of establishing an exact means of com- -paring the future with the present, as to tuberculous diseases, is to construct a Life-Table representing the effects only of Phthisis and other tuberculous diseases in reducing the ranks from year to year of a given number born. So far as known there is no previous work on exactly similar lines, although Dr. Hayward has constructed tables for England, in which the deaths from tuberculous diseases and those from all other causes are given separately.

The importance of the subject seemed to justify the labour entailed, and such a Life-Table, as has been indicated, has been constructed for Scotland for the decennium 1891-1900, in much the same way as the general Life-Table, the difference being that only the deaths from Phthisis and other tuberculous diseases registered during the decennium are considered as causes of death. The distribution of the total lives at risk during the ten years for each age-period has already been accomplished for the general Life-Table, so that it only remains to distribute the deaths from all tuberculous diseases during the decennium. This is done by the graphic method, as is shown in fig. IX for males and fig. X for females.

These two curves distribute the deaths only to the end of the 74th year, as after this age the probability of living a year approximates so closely to unity that the chance of dying from tuberculous diseases is somewhat remote, being in fact less than 1 in 1,000. The numbers resulting from the distribu- -tion are given in table VI appended.

The central populations having been already obtained in the general Life-Table for each year of life from P_5 to P_{74}, and the deaths from tuberculous diseases for the corresponding years/

years having now been also calculated by the graphic method of interpolation, the p_x values from p_5 to p_{74} are got as before. p_0, p_1, p_2, p_3 & p_4 have been calculated by the method advocated by Dr. Hayward, as shown in the corresponding probabilities in the general Life-Table. The p_x column, therefore, has only been taken as far as p_{74}, and the l_x column to l_{75}.

In Table VII appended it will be noticed in the first place that the probability at birth of living a year is lower than at any succeeding age for both males and females. This shows the enormous number of deaths from tuberculous diseases during the first year of life. Here it may be pointed out therefore, that, if tuberculous diseases could be entirely eradicated, children in the first year of life would be bene--fited most of all, and infantile mortality would be thus greatly lowered. The p_x column for males forms a regularly ascending series from p_0 to p_{11}. Thereafter there is a slight annual decline to p_{24}, after which the values of the probabilities again go on increasing each year.

Now in the general Life-Table for Scotland it has been noticed that in the case of males there is a depression at p_{24} consequent on the increased mortality at the age-period 20-25. Moreover, there is a rise in the values from p_{24} to p_{26} for Males. The amount of the rise is as follows:-

$$p_{26} = .9929122$$
$$p_{24} = .9926083$$

∴ Increased value = .0003039 in the general Life-Table.

But, the difference in the corresponding values of the Life-Table in which only tuberculous diseases are considered is as follows:-

$$p_{26} = .9968937$$
$$p_{24} = .9965666$$

∴ Increased value = .0003271.

The/

The second difference is more than the first, and therefore the increase in the second case from p_{24} to p_{26} more than accounts for that in the first.

The conclusion that has been arrived at from all the figures and considerations is that it is most probable that the crest in the curve of distribution of deaths of males at 20-25 is due to an excess of deaths at that period from tuberculous diseases, an excess which has been shown to be decreasing since 1870, so that the curve of distribution of deaths of males in Scotland is fast approximating to that in England. It was shown that the curve for deaths of females in Scotland in 1870 and for some years after presented much the same irregularity, but that in the case of females this irregularity has disappeared, so that the p_x values for females form a series quite similar to that for females in England.

If the above conclusion be correct, the rate of decrease in the crest at 20-25 of the curve representing the deaths of males from all causes may be taken as a kind of measure of the diminish--ed mortality from tuberculous diseases among males in Scotland.

The values in the p_x column (Table VII appended) for females from p_0 to p_4 are higher than the corresponding values for males. From p_5 to p_{19} the values for males are higher, thus showing at ages 5-19 a greater havoc among females than among males. Although the death-rate among females from tuberculous diseases at 20-25 is still high, it is exceeded by that of males, and this is shown by the probabilities for males from p_{20} to p_{27} being lower than for females. From p_{28} to p_{38} the values for males are again slightly greater. From the 39th year of age onwards the probability of females living a year from each year of age maintains a slightly higher level than does the correspond-ing probability for males. These probabilities for males and females/

females have been applied to 1,000,000 born of each sex, the number of survivors at each year of age being shown in Table VII appended.

The survivors out of 1,000,000 born of each sex at several ages are compared in the following table:-

TABLE VIV. NUMBER OF SURVIVORS OUT OF 1,000,000 BORN.
(Phthisis and other Tuberculous Diseases alone being considered as Causes of Death).

Age.	Males.	Females.
0.	1,000,000	1,000,000
5.	980,961	983,386
10.	975,759	977,171
15.	971,476	969,526
20.	960,755	956,132
25.	945,522	942,700
35.	917,887	913,762
45.	891,463	889,976
55.	868,557	875,503
65.	849,190	865,013
75.	837,243	857,947

There is a greater number of female survivors right on to the end of the 12th year. This result is due to the saving effected by the conditions being more favourable for females than for males during the first four years of life. After this period, however, the great tide of tuberculous diseases sets in earlier for females, so that the advantage gained over males in the first four years is gradually lost, until at the thirteenth year the males show the larger number of survivors. From the 13th to the end of the 46th year the male survivors at each age exceed the female. Thereafter the female survivors at each age are in excess of the male.

If, then, tuberculous diseases alone be considered as causes of death, their effect, as deduced from the figures of 1891 to 1900, in thinning the ranks of 1,000,000 of each sex from birth on to 75 years of age, is that 837,243 males and 857,947 females survive. In other words, the deaths of males and females up to 75 years of age would be 162,757 and 142,053 respectively out of 1,000,000 of each sex at birth.

CONCLUSION.

To revert to the figure with which this paper started (viz the likening of a life table to a business man's taking stock) it may be claimed that the labour of the present enquiry is more than repaid by the light which it throws on certain ingredients of the country's statistics, - ingredients which can only be studied when the life-table method of stock-taking is employed. It is as though a large business concern, having in the bulk a satisfactory balance, had by critical examination discovered a particular department acting as a source of loss or of diminishing profits, thus indicating at once the point at which more energy and economy are needed.

Fortunately in this case there is every inducement to supply the fresh energy and every promise of securing the desired economy for the figures point clearly to the particular department which has in the past permitted a disproportionate leakage of vitality. It happens too that during the interval between the period to which these figures relate and the present time a continuous and increasing amount of attention has been paid to the very subject which has been shown by this comparative study of life tables to be the most promising direction for fruitful effort viz,- the crusade against tuberculosis. It is fairly safe to predict that when the life table for the current decade comes to be worked out there will be brought to light a very notable improvement in this department of statistics and an additional incentive to further efforts at restriction until in future life tables the irregularity to which a large part of this paper has been devoted will cease.

LIST OF CHARTS APPENDED.

N.B. The original charts prepared by the author (of which the appended are photographs) can be submitted if required.

LIST OF STATISTICAL TABLES APPENDED.

FIG. I.

Distribution of Population—Males.

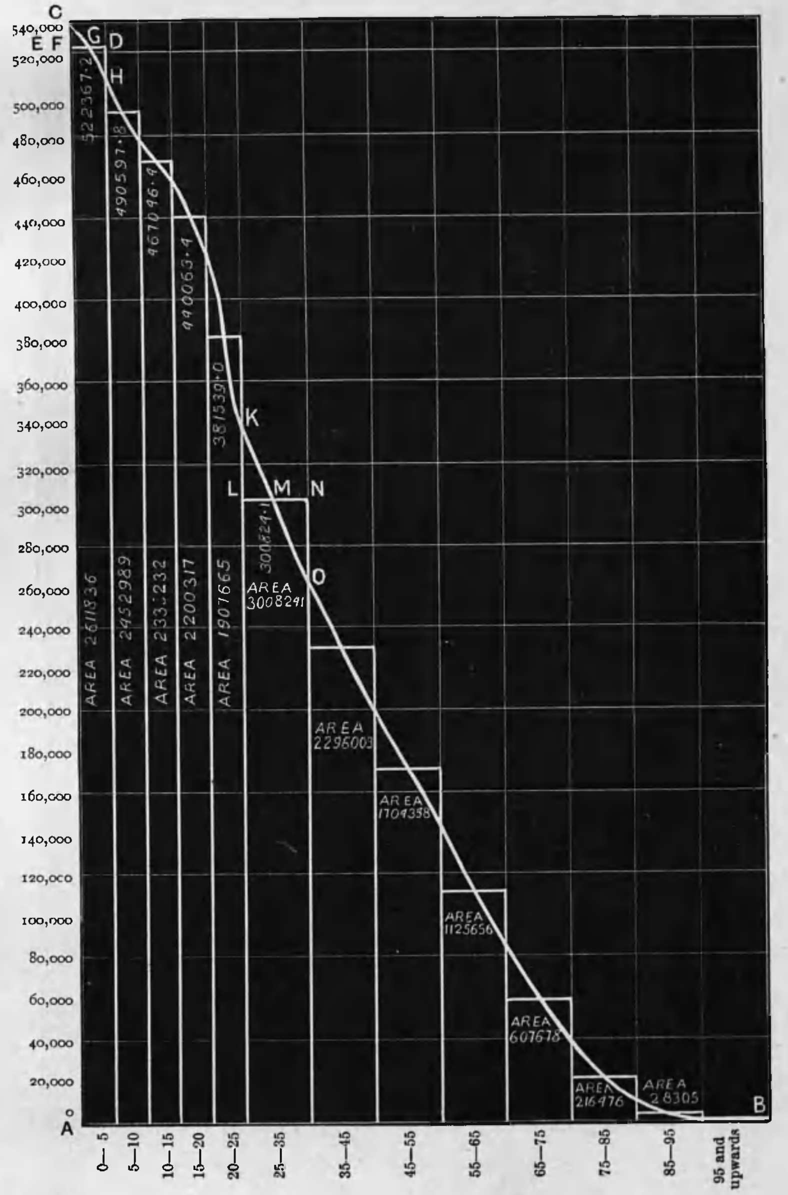
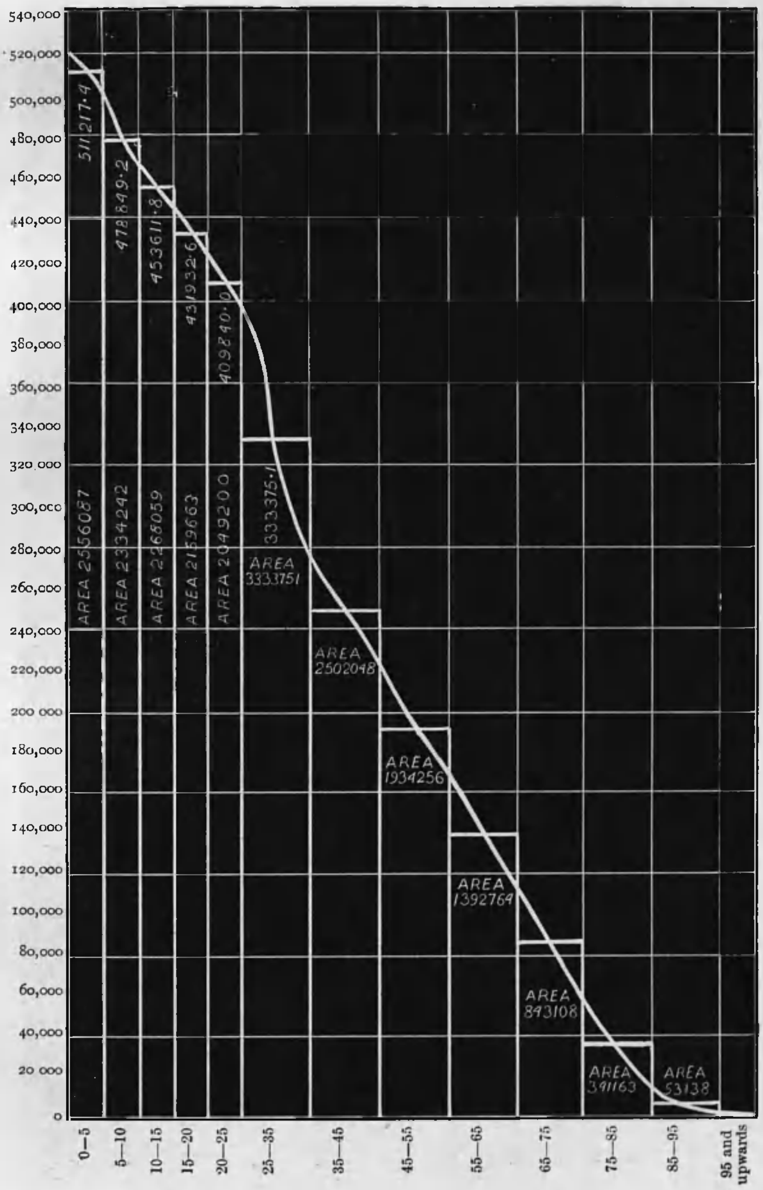


FIG. II.

Distribution of Population—Females.



F I G. III.

DISTRIBUTION OF DEATHS.

M A L E S.

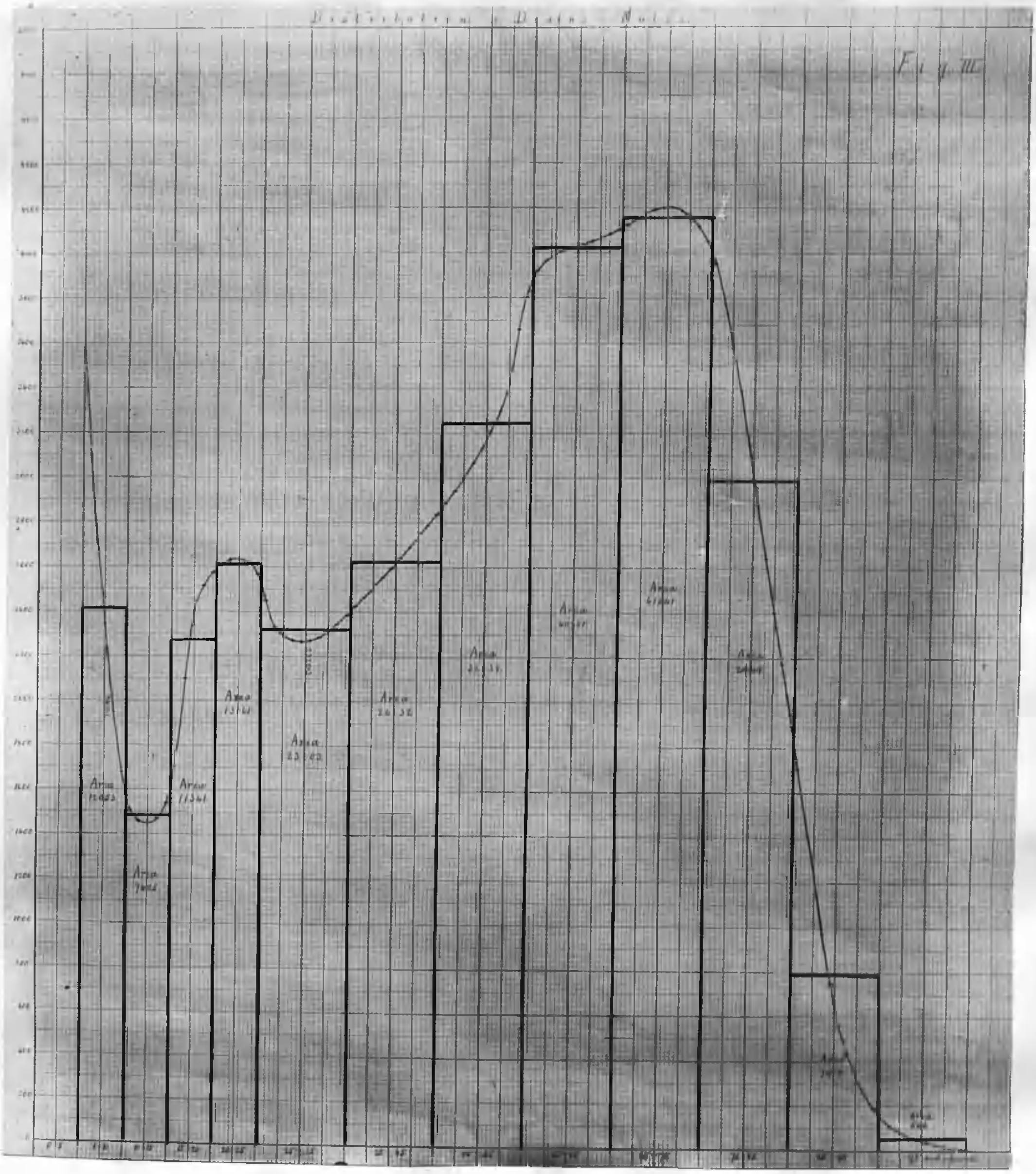
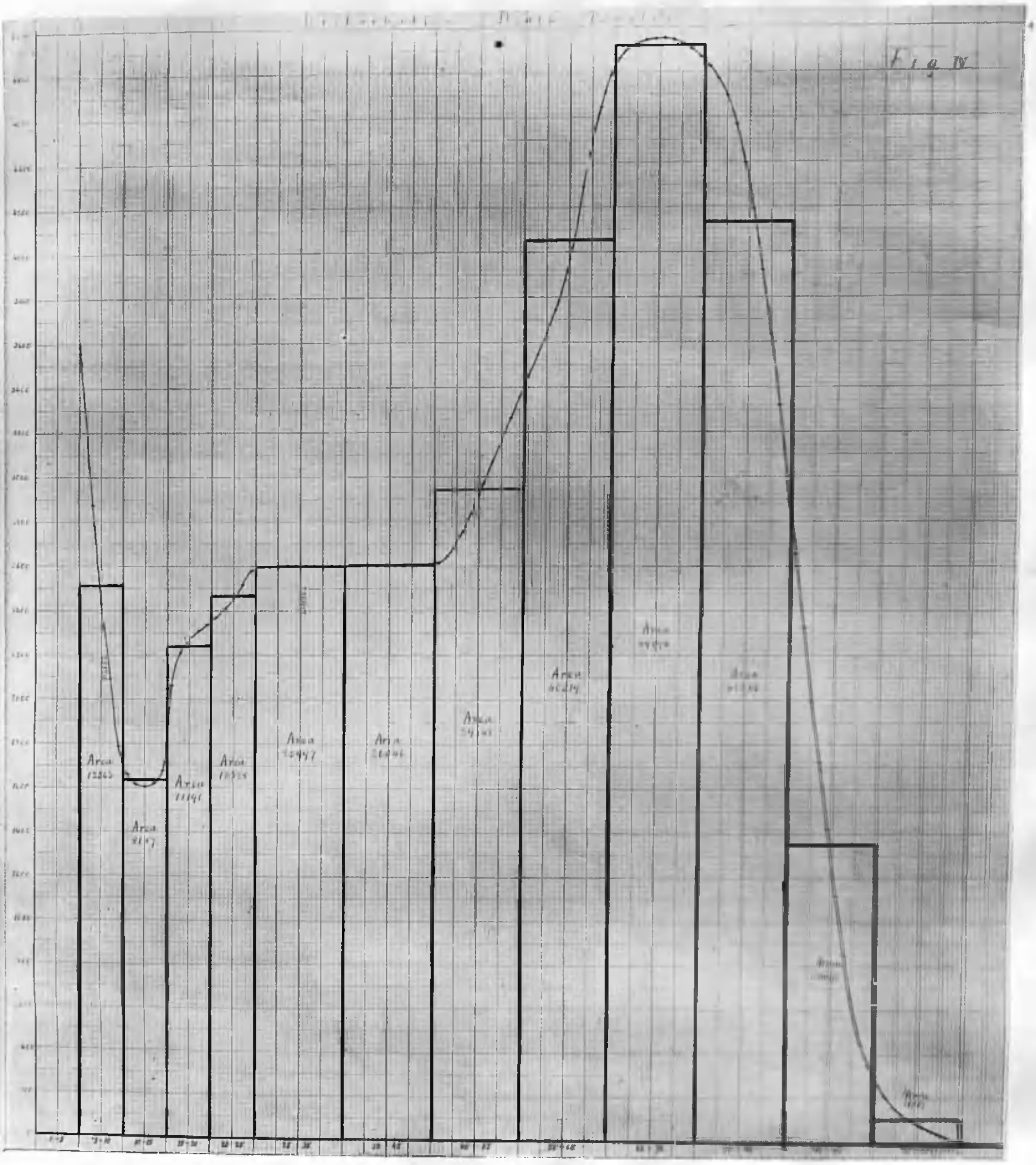


FIG. IV.

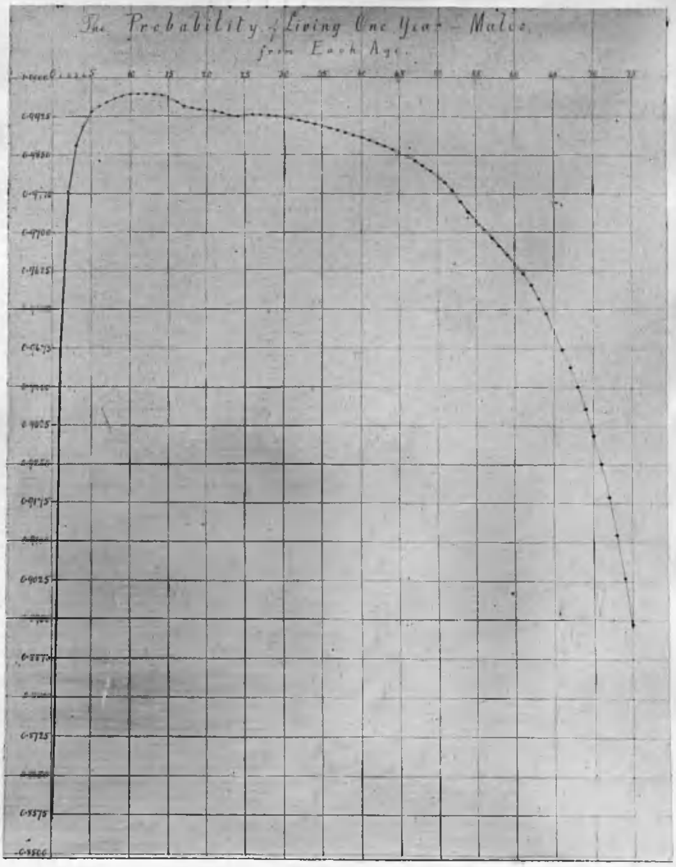
DISTRIBUTION OF DEATHS.

FEMALES.



F I G. V.

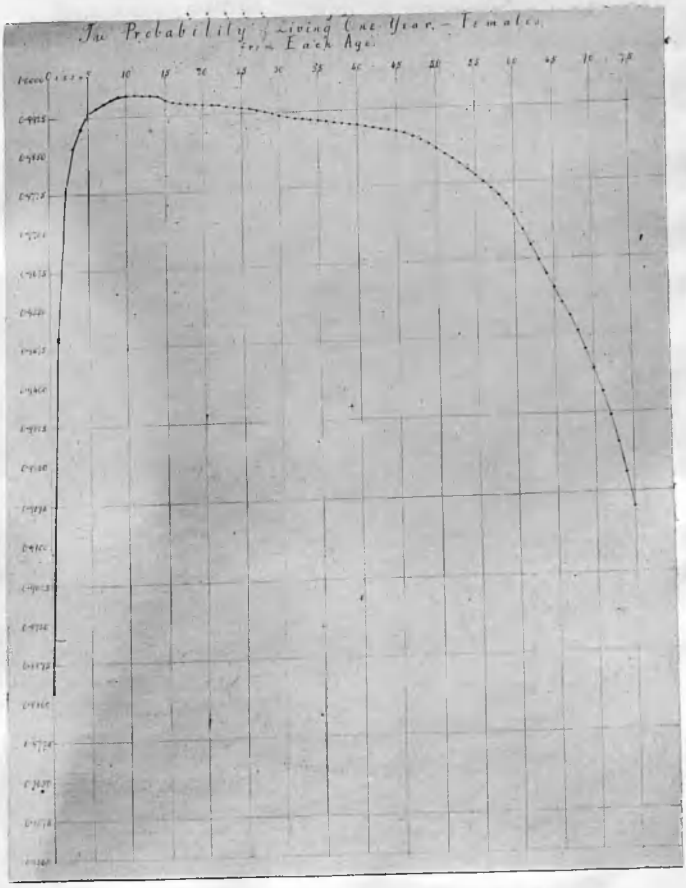
The probability of living one year at each age.   M A L E S.



F I G. V I.

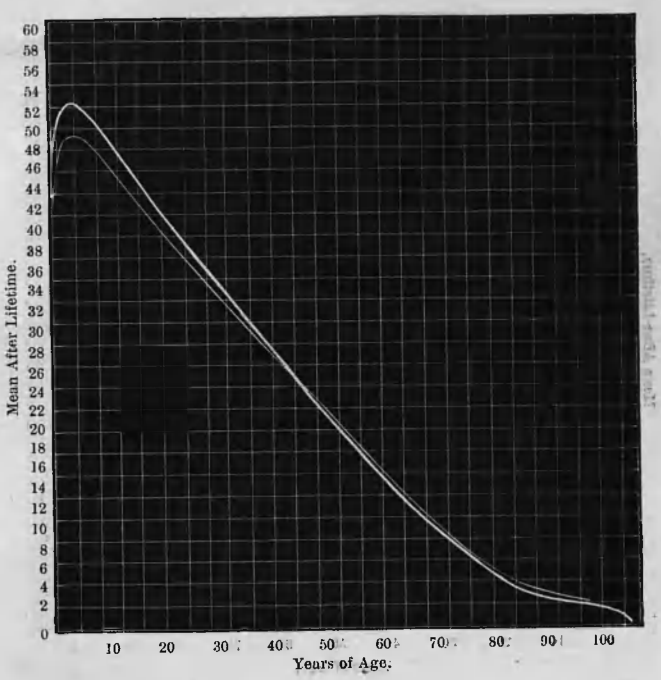
The probability of living one year at each age.

F E M A L E S.



F I G. VII.

Mean After-Lifetime (Expectation of Life)—Males, at each Year of Age.

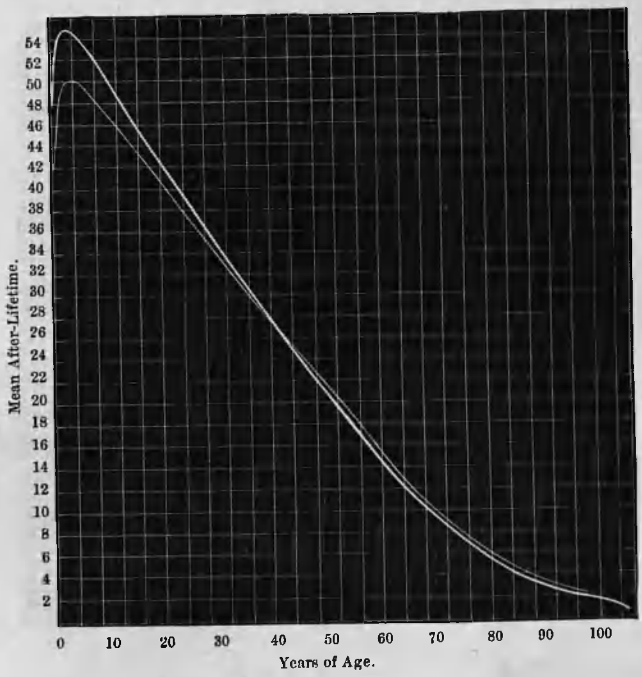


Life Table for Scotland, 1891-1900.

Life Table for Scotland, 1871.

F I G. VIII.

Mean After-Lifetime (Expectation of Life)—Females, at each Year of Age.



Life Table for Scotland, 1891-1900.

Life Table for Scotland, 1871.

F I G. I X.

DISTRIBUTION OF DEATHS

from Phthisis and Other Tuberculous Diseases.

M A L E S.

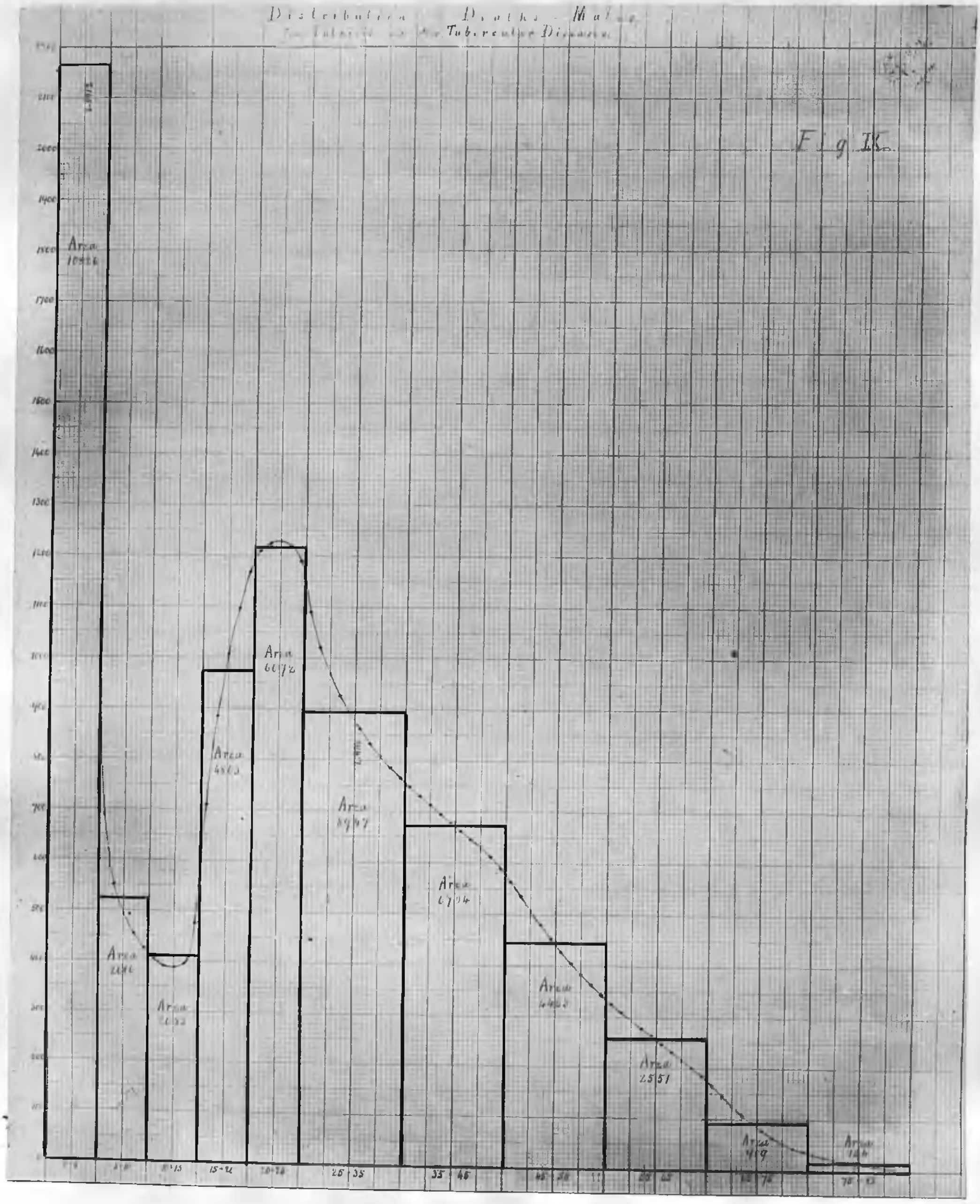


FIG. X.

DISTRIBUTION OF DEATHS

from Phthisis and Other Tuberculous Diseases.

FEMALES.

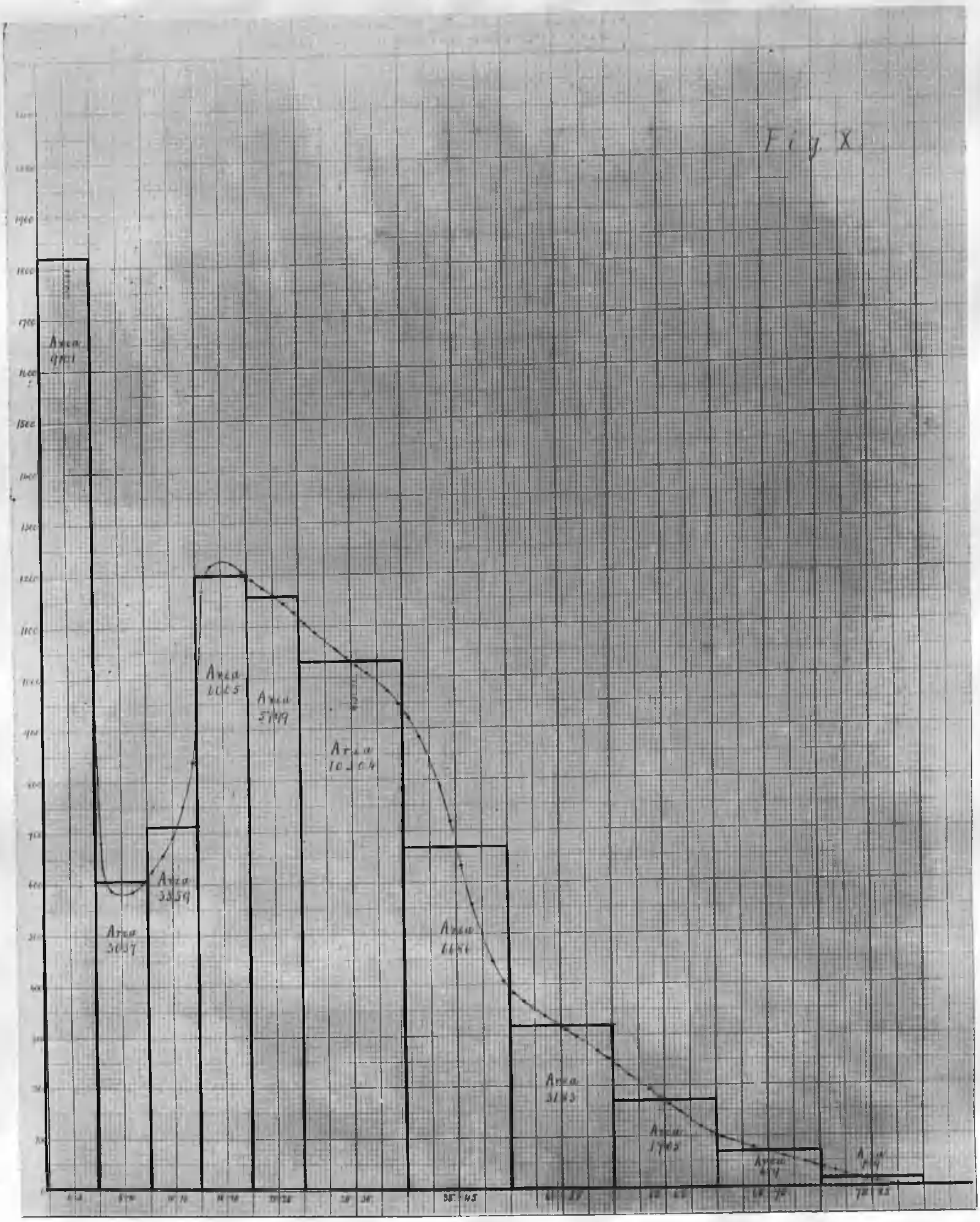


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Table I (Appended).—*Total Number of Lives at Risk and Deaths (1891-1900), Distributed.*

MALES.

Age.	Years of Life at Risk. In Original Groups.	Years of Life at Risk. Distributed.	Deaths. In Original Groups.	Deaths. Distributed.
5		503,800		3,320
6		496,519		2,763
7	2,452,989	489,930	12,053	2,340
8		483,625		1,950
9		479,115		1,680
10		474,900		1,508
11		470,850		1,459
12	2,335,232	467,050	7,425	1,448
13		463,450		1,470
14		458,982		1,540
15		453,600		1,752
16		447,750		2,100
17	2,200,317	440,750	11,341	2,404
18		433,400		2,515
19		424,817		2,570
20		415,250		2,606
21		403,000		2,630
22	1,907,695	383,000	13,061	2,638
23		360,445		2,620
24		346,000		2,567
25		336,941		2,450
26		327,850		2,332
27		319,800		2,290
28		311,900		2,272
29		304,100		2,265
30	3,008,241	296,650	23,203	2,270
31		289,300		2,285
32		281,700		2,310
33		274,000		2,345
34		266,000		2,384
35		258,300		2,424
36		251,700		2,466
37		245,200		2,509
38		238,700		2,552
39		232,250		2,596
40	2,296,003	226,053	26,232	2,641
41		2[illegible]0,000		2,687
42		213,900		2,736
43		207,900		2,785
44		202,000		2,836
45		196,100		2,887
46		190,300		2,940
47		184,550		3,000
48		178,850		3,064
49		173,200		3,128
50	1,704,358	167,800	32,432	3,208
51		162,200		3,295
52		156,450		3,420
53		150,500		3,660
54		144,408		3,830
55		138,400		3,920
56		132,600		3,965
57		126,750		3,992
58		120,800		4,010
59		115,100		4,023
60	1,125,656	109,550	40,251	4,039
61		104,100		4,050
62		98 456		4,067
63		92,800		4,083
64		87,100		4,102
65		81,800		4,123
66		76 928		4,148
67		72,300		4,172
68		67,800		4,188
69		63,200		4,200
70	607,678	58,500	41,541	4,201
71		53,800		4,185
72		49,100		4,158
73		44,450		4,118
74		39,800		4,048
75		35,400		3,950
76		31,800		3,780
77		28,300		3,594
78		25,300		3,386
79		22,550		3,150
80	216,477	19,830	29,919	2,878
81		17,180		2,644
82		14,516		2,404
83		11,900		2,178
84		9,700		1,955
85		7,700		1,710
86		5,850		1,478
87		4,250		1,236
88		3,000		970
89		2,200		744
90	28,305	1,700	7,918	564
91		1,300		440
92		1,000		332
93		710		256
94		595		188

TABLE II (Appended).—*Total Number of Lives at Risk and Deaths* (1891-1900), *Distributed.*

FEMALES.

Age.	Years of Life at Risk.		Deaths.	
	In Original Groups.	Distributed.	In Original Groups.	Distributed.
5		496,400		3,375
6		488,200		2,875
7	2,394,246	478,146	12,563	2,430
8		468,500		2,093
9		463,000		1,790
10		459,650		1,665
11		456,400		1,614
12	2,268,059	454,000	8,187	1,608
13		450,750		1,620
14		447,259		1,680
15		442,750		2,065
16		437,800		2,212
17	2,159,663	431,900	11,191	2,268
18		426,200		2,308
19		421,013		2,338
20		417,200		2,369
21		413,500		2,407
22	2,049,200	410,000	12,328	2,452
23		406,300		2,518
24		402,200		2,582
25		395,300		2,597
26		387,000		2,598
27		375,000		2,599
28		354,000		2,599
29		333,000		2,600
30	3,333,751	317,850	25,997	2,600
31		306,200		2,600
32		296,201		2,601
33		288,000		2,601
34		281,200		2,602
35		275,300		2,602
36		269,600		2,603
37		264,200		2,604
38		258,800		2,604
39		253,300		2,604
40	2,502,048	247,700	26,046	2,605
41		242,000		2,605
42		236,200		2,606
43		230,300		2,606
44		224,648		2,607
45		219,300		2,617
46		213,800		2,646
47		208,056		2,708
48		202,200		2,777
49		196,300		2,871
50	1,934,256	190,300	29,448	2,969
51		184,300		3,067
52		178,800		3,168
53		173 400		3,265
54		167,800		3,360
55		162,400		3,448
56		157,000		3,544
57		152,064		3,642
58		147,100		3,745
59		142,200		3,876
60	1,392,764	137,000	40,519	4,045
61		132,000		4,291
62		12[illegible],400		4,497
63		121,100		4,615
64		115,600		4,786
65		110,000		4,862
66		104,400		4,908
67		98,800		4,926
68		93,100		4 940
69		86,850		4,947
70	843,108	81,100	49,174	4,949
71		75,400		4,946
72		69,900		4,926
73		64,350		4,902
74		59,208		4,868
75		54,200		4,826
76		49,400		4,772
77		44,700		4,696
78		40,000		4,568
79		35,400		4,396
80	341,163	31,300	41,286	4,186
81		27,300		3,920
82		23,400		3,638
83		19,600		3,320
84		15,863		2,964
85		13,000		2,654
86		10,300		2,326
87		8,000		1,997
88		6,300		1,720
89		4,800		1,420
90	53,138	3,800	13,493	1,120
91		2,850		849
92		2,000		614
93		1,300		450
94		788		343

TABLE III (Appended).—LIFE-TABLE FOR SCOTLAND. *Based on the Mortality in the Ten Years* 1891-1900.

MALES.

Age. x.	Dying in Each Year of Age. d_x.	Born, and Surviving at Each Age. l_x.	Population, or Years of Life Lived, in Each Year of Age. P_x.	Population, or Years of Life Lived, in and above Each Year of Age. Q_x.	Expectation of Life at Each Age. E_x.
0	73,458	512,139	462,079	22,896,752	44·71
1	23,192	438,681	427,085	22,434,673	51·14
2	9,197	415,489	410,890	22,007,588	52·97
3	5,381	406,292	403,602	21,596,698	53·16
4	3,745	400,911	399,038	21,193,096	52·86
5	2,609	397,166	395,862	20,794,058	52·36
6	2,190	394,557	393 462	20,398,196	51 70
7	1,870	392,367	391,432	20,004,734	50 98
8	1,571	390,497	389,711	19,613,302	50·23
9	1,361	388,926	388,246	19,223,591	49·43
10	1,229	387,565	386,950	18,835,345	48·60
11	1,195	386,336	385,739	18,448,395	47·75
12	1,192	385,141	384,545	18,062,656	46·90
13	1,216	383,949	383,341	17,678,111	46·04
14	1,282	382,733	382,092	17,294,770	45·19
15	1,470	381,451	380,716	16,912,678	44·34
16	1,778	379,981	379,092	16,531,962	43·51
17	2,057	378,203	377,174	16,152,870	42 71
18	2,176	376,146	375,058	15,775,696	41·94
19	2,256	373,970	372,842	15,400,638	41·18
20	2,325	371,714	370,552	15,027,796	40·43
21	2,403	369,389	368,187	14,657,244	39·68
22	2,519	366,986	365,727	14,289,057	38·94
23	2,640	364,467	363,147	13,923,330	38·20
24	2,675	361,827	360,489	13,560,183	37·48
25	2,602	359,152	357,851	13,199,694	36·75
26	2,527	356,550	355,287	12,841,843	36·02
27	2,526	354,023	352,760	12,486,556	35·27
28	2,551	351,497	350,221	12,133,796	34·52
29	2,589	348,946	347,652	11,783,575	33·77
30	2,640	346,357	345,037	11,435,923	33·02
31	2,704	343,717	342,365	11,090,886	32·27
32	2,785	341,013	339,620	10,748,521	31·52
33	2,882	338,228	336,787	10,408 901	30·77
34	2,992	335,346	333,850	10,072,114	30 03
35	3,104	332,354	330 802	9,738,264	29·30
36	3,210	329,250	327 645	9,407,462	28·57
37	3,319	326,040	324,381	9,079,817	27·85
38	3,432	322,721	321,005	8,755,436	27·13
39	3,549	319,289	317,514	8,434,431	26·42
40	3,667	315,740	313,907	8,116,917	25·71
41	3,788	312,073	310,179	7,803,010	25·00
42	3,918	308,285	306,326	7,492,831	24·30
43	4,050	304,367	302,342	7,186,505	23·61
44	4,187	300,317	298,223	6,884,163	22·92
45	4,328	296,130	293,966	6,585,940	22·24
46	4,474	291,802	289,565	6,291,974	21·56
47	4,633	287,328	285,012	6,002,409	20·89
48	4,802	282,695	280,294	5,717,397	20 22
49	4,974	277,893	275,406	5,437,103	19·56
50	5,168	272,919	270,335	5,161,697	18·91
51	5,385	267,751	265,058	4,891,362	18·27
52	5,673	262,366	259,530	4,626,304	17·63
53	6,168	256,693	253,609	4,366,774	17·01
54	6,557	250,525	247,246	4,113,165	16·42
55	6,814	243,968	240,561	3,865,919	15·85
56	6,987	237,154	233,661	3,625,358	15·29
57	7,137	230,167	226,598	3,391,697	14·74
58	7,283	223,030	219,389	3,165,099	14·19
59	7,411	215,747	212,041	2,945,710	13·65
60	7,542	208,336	204,565	2,733,669	13·12
61	7,663	200,794	196,963	2,529,104	12·60
62	7,816	193,131	189,223	2,332,141	12·08
63	7,978	185,315	181,326	2,142,918	11·56
64	8,160	177,337	173,257	1,961,592	11·06
65	8,317	169,177	165,018	1,788,335	10·57
66	8,446	160,860	156,637	1,623,317	10·09
67	8,548	152,414	148,140	1,466,680	9·62
68	8,620	143,866	139,556	1,318,540	9·17
69	8,699	135,246	130,897	1,178,984	8·72
70	8,773	126,547	122,160	1,048,087	8·28
71	8,818	117,774	113,365	925,927	7·86
72	8,852	108,956	104,530	812,562	7·46
73	8,863	100,104	95,673	708,032	7·07
74	8,831	91,241	86,825	612,359	6·71
75	8,710	82,410	78,055	525,534	6·38
76	8,269	73,700	69,566	447,479	6·07
77	7,813	65,431	61,524	377,913	5·78
78	7,228	57,618	54,004	316,389	5·49
79	6,579	50,390	47,101	262,385	5·21
80	5,928	43,811	40,847	215,284	4·91
81	5,414	37,883	35,176	174,437	4·60
82	4,966	32,469	29,986	138,261	4 29
83	4,612	27,503	25,197	109,275	3·97
84	4,191	22,891	20,795	84,078	3·67
85	3,738	18,700	16,831	63,283	3·38
86	3 356	14,962	13,284	46,452	3·10
87	2,947	11,606	10,133	33,168	2·86
88	2,414	8,659	7,452	23,035	2·66
89	1,872	6,245	5,309	15,583	2·50

TABLE IV (Appended).—LIFE-TABLE FOR SCOTLAND. *Based on the Mortality in the Ten Years* 1891-1900.

FEMALES.

Age. x.	Dying in Each Year of Age. d_x.	Born, and Surviving at Each Age. l_x.	Population, or Years of Life Lived, in Each Year of Age. P_x.	Population, or Years of Life Lived, in and above Each Year of Age. Q_x	Expectation of Life at Each Age. E_x.
0	57,512	487,861	449,695	23,160,931	47·47
1	21.635	430,349	419,531	22,711,236	52·77
2	8,944	408,714	404,242	22,291,705	54·54
3	5,372	399,770	397,084	21,887,463	54·75
4	3,825	394,398	392,486	21,490,379	54·49
5	2,646	390,573	389,250	21,097,893	54·02
6	2,278	387,927	386,788	20,708,643	53·38
7	1,955	385,649	384,671	20,321,855	52·70
8	1,710	383,694	382,839	19,937,184	51·96
9	1,474	381,984	381,247	19,554,345	51·19
10	1,376	380,510	379,822	19,173,098	50·39
11	1,338	379,134	378,465	18 793,276	49·57
12	1,336	377,796	377,128	18,414 811	48·74
13	1,351	376,460	375,785	18,037.683	47·91
14	1,406	375,109	374,406	17,661,898	47·08
15	1,739	373,703	372,833	17,287,492	46·26
16	1,875	371,964	371,027	16,914.659	45·47
17	1,938	370 089	369,120	16,543.632	44·70
18	1,988	368,151	367,157	16,174,512	43·93
19	2,028	366,163	365,149	15,807,355	43·17
20	2,062	364,135	363,104	15,412,206	42·41
21	2,102	362,073	361,022	15 079,102	41·65
22	2,146	359,971	358,898	14,718,080	40·89
23	2,211	357,825	356,719	14,359,182	40·13
24	2,276	355,614	354,476	14,002,463	39·38
25	2,314	353.338	352,181	13,647,987	38·63
26	2,349	351,024	349,850	13,295,806	37·88
27	2,408	348,675	347,471	12,945,956	37·13
28	2,533	346,267	345,000	12,598,485	36·38
29	2,673	343,734	342,398	12,253,485	35·65
30	2,778	341,061	339,672	11,911 087	34·92
31	2,860	338,283	336,853	11,571,415	34·21
32	2,933	335,423	333,956	11.234,562	33·49
33	2,989	332,490	330,996	10,900,606	32·78
34	3,035	329,501	327,983	10,569,610	32·08
35	3,071	326,466	324,931	10,241,627	31·37
36	3,107	323,395	321,841	9,916,696	30·66
37	3,141	320,288	318,718	9,594,855	29·96
38	3,175	317,147	315,559	9,276,137	29·25
39	3,211	313,972	312,367	8,960,578	28·54
40	3 251	310,761	309,135	8,648,211	27·83
41	3,292	307,510	305,864	8,339,076	27·12
42	3,338	304,218	302,549	8,033,212	26·41
43	3,386	300,880	299,187	7,730,663	25·69
44	3,432	297,494	295,778	7,431,476	24·98
45	3,488	294,062	292,318	7,135,698	24·27
46	3,574	290,574	288,787	6,843,380	23·55
47	3,711	287,000	285,145	6,554,593	22·84
48	3,864	283.289	281,357	6 269.448	22·13
49	4,057	279,425	277,396	5,988,091	21·43
50	4,263	275,368	273,237	5,710,695	20·74
51	4,474	271,105	268,868	5,437,458	20·06
52	4,683	266,631	264,289	5,168,590	19·38
53	4,886	261 948	259,505	4,904,301	18·72
54	5,096	257,062	254,514	4,644,796	18·07
55	5,293	251,966	249,320	4,390,282	17·42
56	5,506	246,673	243,920	4,140,962	16·79
57	5,708	241,167	238,313	3,897,042	16·16
58	5,919	235,459	232,499	3,658,729	15·54
59	6,173	229,540	226,454	3,426,230	14·93
60	6,499	223,367	220,117	3,199,776	14·33
61	6,937	216,868	213,400	2 979,659	13·74
62	7,338	209,931	206,262	2,766,259	13·18
63	7,631	202,593	198,777	2,559,997	12·64
64	7,908	194,962	191,008	2,361,220	12·11
65	8,089	187,054	183,010	2,170,212	11·60
66	8,220	178,965	174,855	1,987,202	11·10
67	8,306	170,745	166,592	1,812,347	10·61
68	8,396	162,439	158,241	1,645,755	10·13
69	8,531	154,043	149,777	1,487,514	9·66
70	8,617	145,512	141,204	1,337,737	9·19
71	8,695	136,895	132,547	1,196,533	8·74
72	8,727	128,200	123,837	1,063,986	8 30
73	8,767	117,473	115,089	940,149	7·87
74	8,743	110,706	106,335	825,060	7·45
75	8,692	101,963	97,617	718,725	7·05
76	8,595	93,271	88,973	621,108	6·66
77	8,452	84,676	80,450	532,135	6·28
78	8,235	76,224	72,107	451,685	5·93
79	7,949	67,989	64,014	379,578	5·58
80......	7,526	60,040	56,277	215,564	5·26
81......	7,035	52,514	48,997	259,287	4·94
82......	6,561	45,479	42,198	210,290	4·62
83......	6,078	38,918	35,879	168,092	4·32
84......	5,612	32,840	30,034	132,213	4 03
85......	5,044	27,228	24,706	102,179	3·75
86......	4,501	22,184	19,934	77,473	3·49
87......	3,924	17,683	15,721	57,539	3·25
88......	3,310	13,759	12,104	41,818	3·04
89......	2,712	10,449	9,093	29,714	2·84

Table V (Appended).

Age. x.	The Probability of Living One Year from Each Age. p_x.		Of 1,000 000 Born of each Sex, the Number Surviving at Each Age.	
	Males.	Females.	Males.	Females.
0	0·8565670	0·8821140	1,000,000	1,000,000
1	0·9471315	0·9497273	856,567	882,114
2	0·9778636	0·9781168	811,282	837,768
3	0·9867563	0·9865614	793,323	819,435
4	0·9906591	0·9903023	782,816	808,423
5	0 9934317	0·9932241	775,504	800,583
6	0·9944507	0·9941283	770,410	795,158
7	0·9952352	0·9949308	766,134	790,489
8	0·9959761	0·9955423	762,483	786,482
9	0·9964997	0·9961414	759,415	782,976
10	0·9968296	0·9963842	756,757	779,955
11	0 9969061	0·9964699	754,358	777,135
12	0·9969045	0·9964644	752,024	774,392
13	0·9968332	0·9964124	749,696	771,654
14	0·9966503	0·9962508	747,322	768,856
15	0·9961450	0·9953468	744,819	766,003
16	0·9953209	0·9949602	741,948	762,439
17	0·9945605	0·9947625	738,476	758,596
18	0·9942138	0·9945993	734,460	754,623
19	0·9939686	0·9944621	730,211	750,548
20	0·9937439	0·9943377	725,807	746,391
21	0·9934952	0·9941959	721,267	742,165
22	0·9931359	0·9940373	716,575	737,857
23	0·9927575	0·9938218	711,656	733,457
24	0·9926083	0·9936008	706,502	728,925
25	0·9927550	0·9934518	701,279	724,260
26	0·9929122	0·9933093	696,198	719,517
27	0 9928648	0·9930933	691,263	714,703
28	0·9927420	0·9926850	686,331	709,766
29	0 9925794	0·9922226	681,351	704,575
30	0·9923771	0·9918534	676,295	699,095
31	0·9921327	0·9915447	671,141	693,400
32	0·9918333	0·9912572	665,861	687,537
33	0·9914781	0·9910093	660,423	681,526
34	0·9910776	0·9907894	654,795	675,399
35	0·9906594	0·9905929	648 953	669,178
36	0·9902504	0·9903913	642,892	662,883
37	0 9898196	0·9901922	636,624	656,514
38	0·9893656	0 9899885	630,143	650,075
39	0·9888845	0·9897723	623,442	643,567
40	0·9883848	0·9895383	616,513	636,986
41	0·9878 05	0·9892932	609,352	630,322
42	0·9872903	0·9890275	601,955	623,574
43	0·9866933	0·9887480	594,3 5	616,732
44	0·9860583	0·9884621	586,397	609,793
45	0·9853855	0·9881373	578,222	602,757
46	0·9846691	0·9877001	569,771	595,607
47	0·9838753	0 9870684	561,036	588,281
48	0·9830138	0·9863597	551,989	580,674
49	0·9821016	0·9854806	542,613	572,754
50	0·9810630	0·9845191	532,901	564,438
51	0·9798898	0·9834960	522,809	555,700
52	0·9783763	0 9824375	512,295	546,529
53	0·9759732	0 9813463	501,217	536,931
54	0·9728250	0·9801747	489,174	526,916
55	0·9720708	0·9789915	476,370	516,470
56	0·9705385	0·9776787	463,065	505,620
57	0·9689932	0 9763330	449,422	494,334
58	0·9673466	0·9748611	435 487	482,635
59	0·9656481	0·9731091	421,267	470,502
60	0·9637983	0·9709040	406,796	457,850
61	0·9618375	0·9680123	392,069	444,528
62	0·9595281	0·9650443	377,107	430,309
63	0·9569492	0·9623345	361,845	415,267
64	0·9539882	0·9594383	346,267	399,626
65	0·9508356	0·9567557	330,335	383,416
66	0·9474950	0·9540682	314,094	366,836
67	0·9439142	0·9513544	297,603	349,987
68	0·9400607	0·9483101	280,912	332,962
69	0 9356815	0·9446170	264,080	315,751
70	0·9306771	0·9407834	247,095	298,264
71	0·9251241	0·9364863	229,966	280,602
72	0·9187557	0·9319265	212,747	262,780
73	0·9114580	0·9266179	195,463	244,891
74	0·9032135	0·9210279	178,156	226,920
75	0·8943144	0·9147546	160,913	209,000
76	0·8878005	0 9078515	143,907	191,184
77	0 8805861	0 9001870	127,761	173,566
78	0·8745601	0·8919686	112,505	156,242
79	0·8694301	0 8830789	98,392	139,363
80	0·8646857	0 8746444	85,545	123,068
81	0·8570965	0·8660287	73,970	107,641
82	0·8470543	0·8557437	63,399	93,220
83	0·8323197	0·8438382	53,702	79,772
84	0·8169047	0·8291150	44,697	67,314
85	0·8001169	0·8147554	36,513	55,811
86	0·7756868	0·7970863	29,215	45,472
87	0·7460970	0·7780741	22,662	36,245
88	0·7212	0·7594	16,908	28,202
89	0·7002	0·7405	12,194	21,417

TABLE V1 (Appended).

Total number of Deaths in Scotland from Phthisis and other Tuberculous Diseases (1891-1900) distributed.

Age	DEATHS OF MALES. In original Groups.	DEATHS OF MALES. Distributed.	Age	DEATHS OF FEMALES. In original Groups.	DEATHS OF FEMALES. Distributed.
5		690	5		682
6		551	6		588
7	2,616	495	7	3,037	582
8		455	8		585
9		425	9		600
10		405	10		627
11		390	11		655
12	2,053	388	12	3,559	691
13		395	13		750
14		475	14		836
15		710	15		1,130
16		885	16		1,219
17	4,863	1,005	17	6,005	1,226
18		1,095	18		1,222
19		1,168	19		1,208
20		1,210	20		1,190
21		1,224	21		1,175
22	6,072	1,228	22	5,799	1,161
23		1,220	23		1,145
24		1,190	24		1,128
25		1,090	25		1,106
26		1,020	26		1,088
27		970	27		1,071
28		925	28		1,056
29	8,947	890	29	10,304	1,038
30		860	30		1,022
31		832	31		1,009
32		808	32		993
33		786	33		973
34		766	34		948
35		749	35		920
36		730	36		882
37		713	37		838
38		695	38		785
39	6,704	678	39	6,686	718
40		662	40		632
41		646	41		558
42		630	42		500
43		612	43		446
44		589	44		407
45		563	45		384
46		536	46		367
47		507	47		352
48		480	48		339
49	4,463	453	49	3,183	325
50		427	50		310
51		405	51		298
52		384	52		285
53		364	53		269
54		344	54		254
55		326	55		239
56		310	56		222
57		294	57		207
58		279	58		192
59	2,551	264	59	1,705	176
60		247	60		162
61		231	61		149
62		216	62		132
63		200	63		119
64		184	64		107
65		165	65		98
66		145	66		91
67		125	67		85
68		108	68		79
69	909	92	69	699	72
70		77	70		66
71		64	71		60
72		51	72		55
73		44	73		49
74		38	74		44

TABLE VII.

TABLE

Based on the Mortality of Ten Years (1891-1900) from Phthisis and other Tuberculous Diseases in Scotland.

Age. x	The Probability of Living One Year from each Age (0-74), - only Phthisis and other Tuberculous Diseases being considered as Causes of Death. p_x		Of 1,000,000 born of each Sex, the Number Surviving at each Age only Phthisis and other Tuberculoud Diseases being considered as Causes of Death. l_x	
	Males.	Females.	Males.	Females.
0	.9954393	.9947151	1,000,000	1,000,000
1	.9941918	.9949148	995,439	994,715
2	.9969075	.9972478	987,669	989,657
3	.9979339	.9980228	984,615	986,933
4	.9983513	.9983796	982,581	984,982
5	.9986315	.9986271	980,961	983,386
6	.9988909	.9987963	979,618	982,036
7	.9989902	.9987835	978,532	980,854
8	.9990596	.9987521	977,544	979,661
9	.9991133	.9987049	976,625	978,438
10	.9991476	.9986568	975,759	977,171
11	.9991721	.9985659	974,927	975,859
12	.9991696	.9984791	974,120	974,440
13	.9991481	.9983375	973,311	972,958
14	.9989656	.9981326	972,482	971,340
15	.9984560	.9974510	971,476	969,526
16	.9980254	.9972195	969,957	967,055
17	.9977224	.9971654	968,042	964,366
18	.9974767	.9971369	965,837	961,632
19	.9972544	.9971348	963,400	958,879
20	.9970905	.9971517	960,755	956,132
21	.9969674	.9971624	957,959	953,409
22	.9967989	.9971723	955,054	950,704
23	.9966210	.9971659	951,997	948,016
24	.9965666	.9971994	948,780	945,348
25	.9967702	.9972060	945,522	942,700
26	.9968937	.9971926	942,468	940,066
27	.9969715	.9971481	939,540	937,427
28	.9970387	.9970214	936,695	934,754
29	.9970776	.9968877	933,921	931,970
30	.9971052	.9967898	931,192	929,069
31	.9971282	.9967102	928,496	926,087
32	.9971358	.9966532	925,830	923,040
33	.9971355	.9966272	923,178	919,951
34	.9971244	.9966344	920,534	916,848
35	.9971045	.9966662	917,887	913,762
36	.9971039	.9967526	915,229	910,716
37	.9970964	.9968320	912,578	907,740
38	.9970926	.9969725	909,928	904,864
39	.9970850	.9971672	907,282	902,125
40	.9970758	.9974528	904,637	899,569
41	.9970679	.9976969	901,992	897,278
42	.9970590	.9978845	899,347	895,211
43	.9970606	.9980653	896,702	893,317
44	.9970884	.9981907	894,066	891,589
45	.9971331	.9982513	891,463	889,976
46	.9971874	.9982846	888,907	888,420
47	.9972565	.9983091	886,407	886,896
48	.9973198	.9983248	883,975	885,396
49	.9973879	.9983474	881,606	883,913
50	.9974585	.9983706	879,303	882,452
51	.9975062	.9983826	877,068	881,014
52	.9975486	.9984091	874,881	879,589
53	.9975843	.9984508	872,736	878,190
54	.9976207	.9984865	870,628	876,830
55	.9976473	.9985285	868,557	875,503
56	.9976649	.9985870	866,514	874,215
57	.9976832	.9986406	864,491	872,980
58	.9976931	.9986956	862,488	871,793
59	.9977090	.9987631	860,498	870,656
60	.9977479	.9988182	858,527	869,579
61	.9977834	.9988719	856,594	868,551
62	.9978085	.9989554	854,695	867,571
63	.9978471	.9990170	852,822	866,665
64	.9978897	.9990756	850,986	865,813
65	.9979849	.9991095	849,190	865,013
66	.9981169	.9991300	847,479	864,243
67	.9982726	.9991387	845,883	863,491
68	.9984083	.9991509	844,422	862,747
69	.9985454	.9991704	843,078	862,014
70	.9986846	.9991875	841,852	861,299
71	.9988111	.9992046	840,745	860,599
72	.9989618	.9992135	839,745	859,914
73	.9990106	.9992388	838,873	859,238
74	.9990457	.9992584	838,043	858,584
75			837,243	857,947