THE BRIGHTON LIFE TABLE

BY

ARTHUR NEWSHOLME M. D.


COLL. REG. MED. LOND.
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Sir Andrew Clark, Bart.

with the respect of A.N.

THE

BRIGHTON LIFE TABLE

(Based on the Mortality of the Ten Years, 1881–90).

BY

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PREFACE.

A Life Table furnishes the most trustworthy measure of the vital conditions of a community. There are, however, serious difficulties in its application to comparatively small localities, and these account for a large share of the delay in the issue of the present Life Table.

In the first place, the difficulty arises of obtaining the requisite data. The census population of Brighton, distributed according to age and sex, has not yet been published; and had it not been for the courtesy of Dr. Ogle Superintendent of Statistics in the General Register Office, Somerset House, the Brighton Life Table could not have been hitherto commenced. I take this opportunity of expressing my cordial acknowledgment of the kindness received from Dr. Ogle and his assistants.

When the necessary data as to population and deaths were secured, a further difficulty arose. The more carefully the data as to deaths were examined, the more evident it became that they embraced a number of deaths not properly belonging to the Municipal Borough of Brighton. Had these deaths been excluded from the Life Table an initial suspicion would have attached thereto. The alternative plan was adopted of embracing within the Life Table the population and deaths of Hove, and including also the deaths of inhabitants of Brighton and Hove, which occurred in public institutions without their borders. Hence this Life Table refers to the Parliamentary Borough of Brighton.

The method adopted in the construction of the Brighton Life Table is not the analytical method usually employed, but the graphic method, which, as shewn by Mr. Geo. King, the Hon. Sec. of the Institute of Actuaries, was the method employed by Milne in the construction of his famous Carlisle Table.

Mr. King has criticised the curves given in pages 12-13, and I am greatly indebted to him for valuable guidance and help. Mr. Frankland, F.I.A., has also kindly given help in several points of difficulty. I am, however, alone responsible for the accuracy of the Life Table.

The adaptation of the graphic method of constructing a Life Table to public health purposes, represents, I think, an important improvement. For not only is the method very accurate when properly applied, but it is also simple in application. The graphic method brings the construction of a Life Table within the reach of every medical officer of health, and thus supplies him with an instrument of increased accuracy for calculating the exact vital conditions of the community whose health he is appointed to guard.

ARTHUR NEWSHOLME.

Town Hall, Brighton,

May 10th, 1893.

PLATE I.

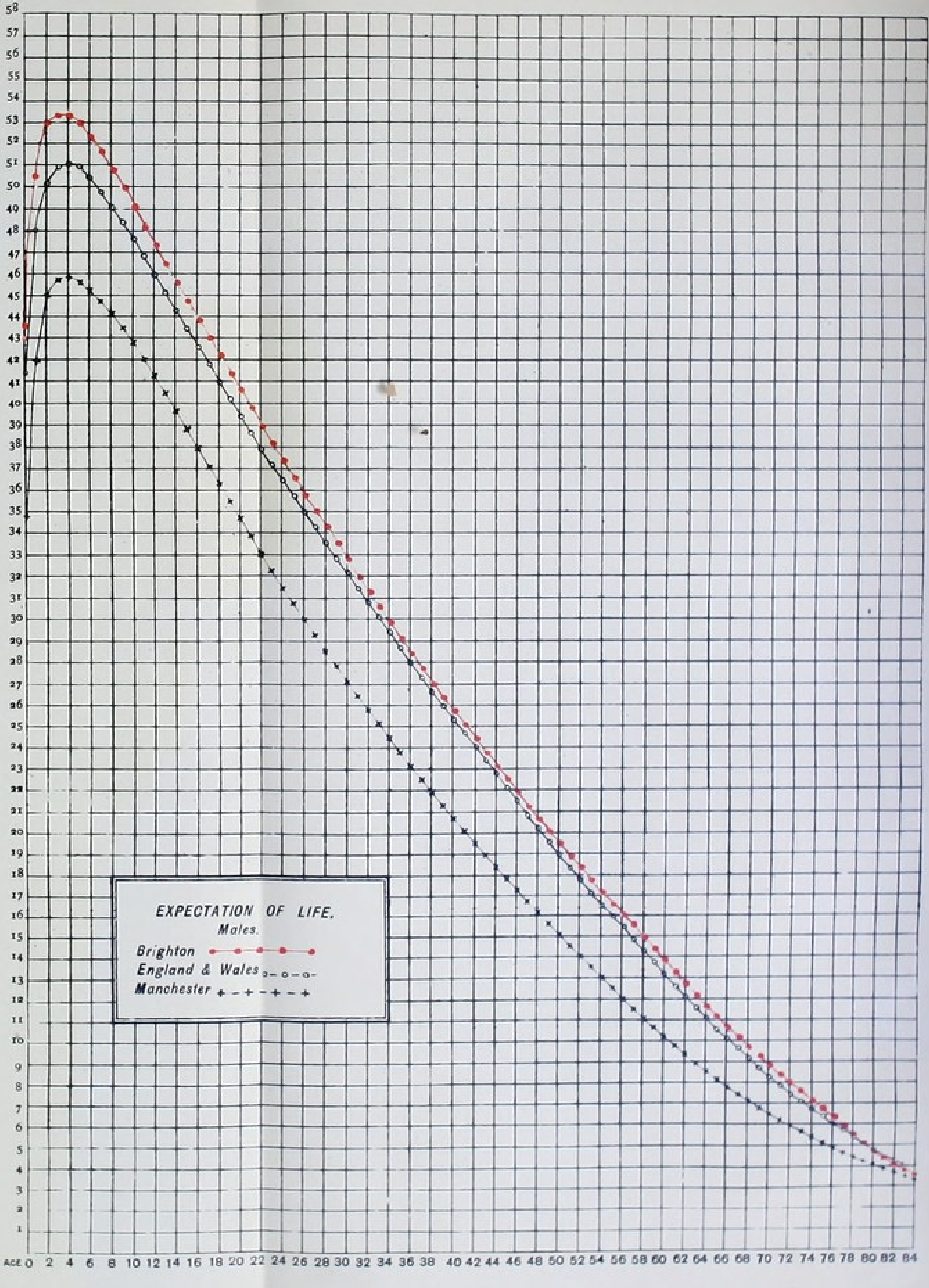
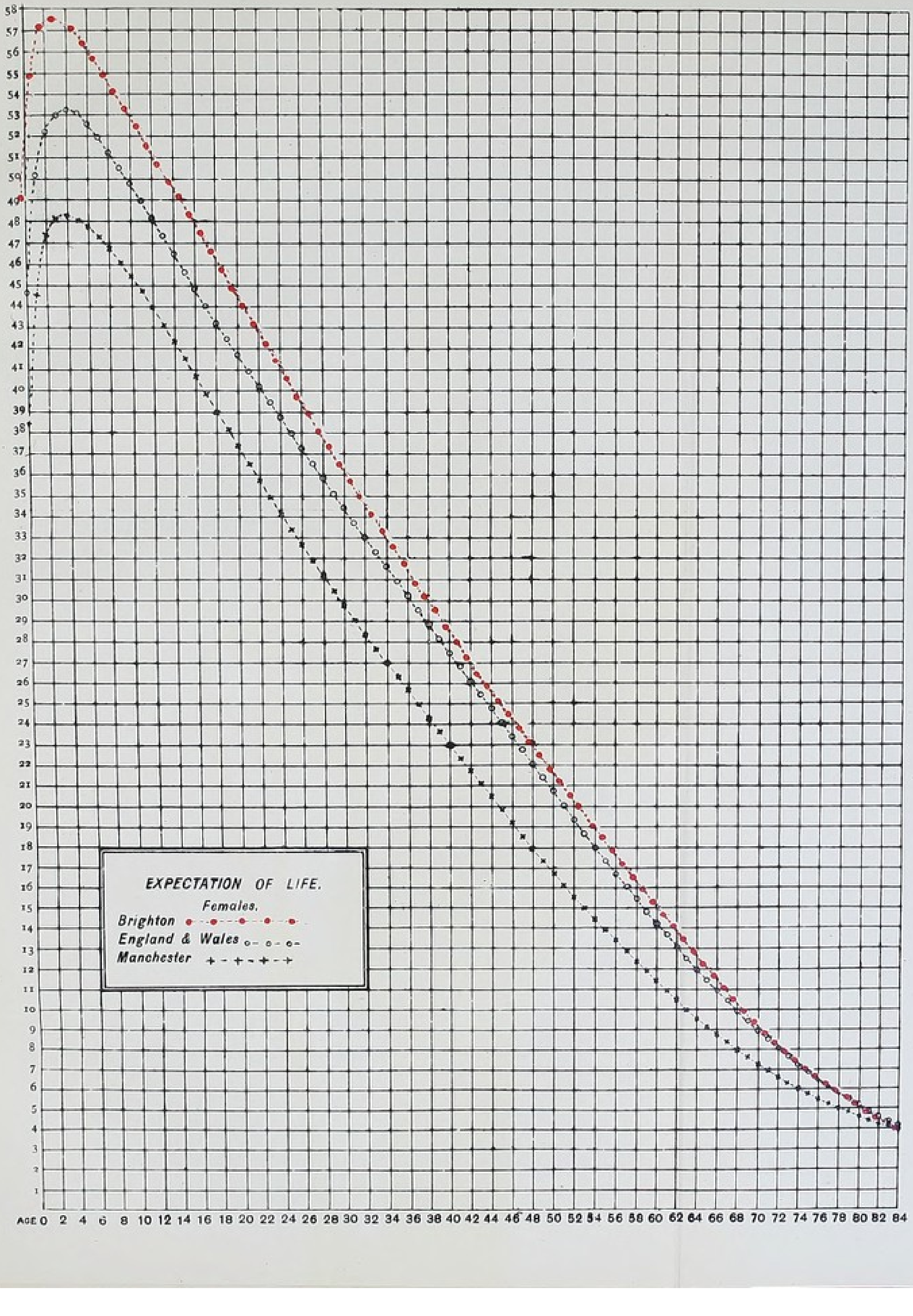

EXPECTATION OF LIFE.
Males.
Brighton
England & Wales
Manchester
AGE 0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84

PLATE II.



EXPECTATION OF LIFE.
Females.
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AGE

THE BRIGHTON LIFE TABLE.

A.—Data.

Local death-rates are always interesting to those having at heart the welfare of the locality concerned. It has, however, been repeatedly shewn that these local death-rates are not absolutely accurate, as they do not take into account the varying constitution of populations as to the proportion of the two sexes and of persons at ages of greater or less mortality; and in many cases they do not include the deaths of inhabitants of the given locality who die in public institutions outside its borders.

Although the effect of varying age and sex constitution is confined within somewhat narrow limits, in an accurate statement of rates of mortality it must be eliminated, and this can be accomplished most perfectly by means of a Life Table. By means of such a Life Table for Brighton, we can completely eliminate the disturbing influence arising from the excessive number of old people who are stated on the one hand to unduly raise its death-rate; as also the opposite effect caused by an excessive proportion of females, especially at the ages of lowest mortality, and by a proportion of children under five below the average of that for the great towns.

A further advantage of a Life Table formed like the present from the figures as to life and death in Brighton during a period of ten years, is that the variations in mortality necessarily occurring in single years are counterbalanced, and a correct determination of the true chances of life is obtained, assuming that the vital conditions of the decade 1881-90 continue to hold good.

The results of a Life Table being such that they may be stated in the form of the "expectation of life," *i.e.*, the number of years which persons of a given age taken one with another will continue to live, their significance is greater and more easily understood than that of a mere statement of the number dying in a year out of a thousand persons of varying ages.

Data for a Life Table.—The data on which a Life Table is formed are the number and ages of the living and the number and ages of the dying. The ideal life table represents "a generation of individuals passing through time," and measures the probabilities of life and death of this generation at birth, and of the survivors at each successive age until the whole generation becomes extinct. Hence Dr. Farr calls a Life Table a *biometer*, and speaks of it as of equal importance, in all enquiries connected with human life or sanitary improvements, with the barometer or thermometer and similar instruments employed in physical research.

(a). In such an ideal life table, supposing 100,000 children to be born at the same moment, this number and the number surviving at each successive age would be entered in a column which is headed by the symbol l_x; where l_x represents the number who reach the precise age x.

In a second column, the number out of the 100,000 children starting life together who die before the completion of each year of life would be entered. Thus the number who die before reaching the first anniversary are placed opposite the age 0 in the table, and so on. In this way we obtain the column headed d_x; where d_x represents the number out of l_x persons attaining the precise age x, who die before reaching the age $x + 1$.

In practice it is not possible to observe a number of children through the different stages of life until the last has died, in the precise manner above indicated; and even were it practicable, the results obtained, although they would possess a historic value, would not give a trustworthy indication of the probabilities of life at the present time.

(b). It is not necessary, however, to assume as in the preceding case, that all the persons observed have been born at the same time. If we could trace any 100,000 children throughout life, however various might be the dates of their births, a Life Table might be similarly constructed, if the numbers living and dying during each year of life were known.

(c). We may go a step further, and state that it is not necessary for the construction of a trustworthy Life Table to trace the history of individual children. If we know the population at each year of age living in a district at the commencement of any year, and the number of deaths for each year of age during the whole of the corresponding year,—it being assumed that with the exception of those who die during the year, each member of the population lives throughout the entire year within the district under observation,—we have an example of a population at various ages from birth to the most advanced age, suffering from the mortality incident to these various ages during an actuarial unit of time, *i.e.*, a year; and this may be taken as comparable to the generation of persons traced through life, and subjected at each successive year to the mortality incident to that age until the whole generation became extinct.

The results founded on a single year's mortality experience, would as already indicated possess one great advantage over the results derived from the observation of "a generation of individuals passing through time." They would be up to date and would therefore give a more accurate estimate of the present probabilities of life and death than the latter. They would, however, be open to objection because of paucity of data, and because they might represent an extreme value in a series of years of varying mortality. For this reason, in the present Life Table the results of ten years have been taken as the basis on which the probabilities of life and death have been calculated.

The population of the Parliamentary Borough of Brighton at the census of 1881 was 128,350; at the census of 1891 it was 141,970. The deaths occurring from January 1st, 1881, to December 31st, 1890, numbered 23,768, making the mean annual death-rate 17·65 per 1,000. Out of these data, which are set forth in detail in Table II., the Brighton Life Table has been constructed.

DEGREE OF TRUSTWORTHINESS OF DATA.—The migratory character of a large proportion of its population appears at first sight to throw doubt on the trustworthiness of the data forming the basis for a Life Table for Brighton. Assuming, however, that the age, sex and condition of health of 12,000 persons living in Brighton for a single month are identical with that of 1,000 persons living in Brighton for twelve months, the effect of the two groups of persons upon the death-rate, and therefore upon the probabilities of life as ascertained by a Life Table, would be identical. It is impossible to say that the migratory portion of the population of Brighton fulfils conditions which exactly balance in the manner just indicated. After a careful consideration of the problem founded on local knowledge and investigation, the conclusion at which I have arrived is that in the figures hereafter used for a Life Table, Brighton is handicapped by a considerable under-statement of population and a slight over-statement of the deaths occurring during the decade 1881-90. Let me explain these statements in further detail.

(a). Under-statement of Population. The census enumerations in 1881 and 1891 were early in the month of April. The population for each intervening year and the total population for the whole decade (see p. 12) are based on these enumerations. Now in April the population of Brighton is probably at its lowest or nearly its lowest ebb; its hotels and lodging-houses are comparatively empty; and the population of that month if accepted as the basis for calculation (as in this investigation) is so accepted in order to avoid any possible cavil under the next head.

(b). Over-statement of Deaths. The deaths of inhabitants of Brighton in outlying institutions, such as the Shoreham Workhouse and Hangleton Fever Hospital have been properly included in the death-returns for the decennium; but it has not been thought necessary to make an addition to the population equal (were it known) to the portion of the Brighton population living in these external institutions.

During the summer and autumn, Brighton has a much larger number of visitors than in the first four months of the year. Of these visitors a certain proportion die in the town; and in so far as these deaths occur among a larger population of visitors than is present in Brighton in the month of April, the death rate (which is based on an estimate of the population calculated from the April enumerations) is over-stated. The deaths of visitors ought to be included in the total number of deaths in Brighton ; but if the population does not include an equally full proportionate number of visitors, the death-rate must to a corresponding extent be over-stated.

In addition to the deaths of visitors in excess of the enumerated population of visitors, it must be remembered that Brighton contains the Sussex County Hospital and the Alexandra Hospital for Children, which draw patients from the entire county, thus swelling the general death-rate.*

It has also been urged that Brighton being a health resort, the persons who visit and settle here are to a larger extent invalids with a poorer prospect of life than average persons of the same age. This probably operates among the poor to a greater extent than is commonly supposed ; a large number of needy phthisical patients who die here have arrived within six or twelve months of their deaths. Among the rich, the effect of invalid immigration is to a large extent counteracted by the healthy servants and others who come with the invalids.†

(c). Possible under-statement of Deaths. A glance at Plate III., page 12 will shew how large an excess of females, especially at the ages 15-35, there is in the Brighton population, due to the large number of female servants, shop-assistants, &c., at these ages. Do the figures as to deaths among females at these ages give the total number of deaths occurring in the corresponding population ? The majority of domestic servants are drawn from rural districts, and it is well-known that when servants fall ill, they are usually, if the illness is acute in character, sent into hospital, and if it is chronic to their homes. Thus the death-rate of rural districts at these ages is apt to be over-stated, and that of towns to be under-stated.

The comparison between Brighton and the whole of England in Table I. seems to shew traces of such disturbance. There is no reason to suppose that such transfer of moribund females occurs at the ages 5-10 and 10-15 ; but it is probable that at the ages 15-20, 20-25 and 25-35, a certain

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* The extent to which the County Hospital receives patients from outside Brighton may be gathered from the figures for the three years 1890-92. In these three years 340 patients died in the County Hospital, of whom 61 came from rural districts and 8 from London, equal to 20·3 per cent. of the total deaths in this Institution.

† During 1892, systematic inquiries into the history of all patients dying of phthisis in Brighton were commenced. The returns for the first year are not complete ; but they shew that at least 10 per cent. of the total deaths from phthisis were imported cases.

proportion (say 10 or 20 per cent.) of the percentage deficiency of the Brighton death-rate as compared with that of the whole country may be caused by this transfer of fragile lives aged 15-35 to rural districts. It is impracticable to introduce any correction for this possible error of data: but it is probable that the under-statement of population and the over-statement of deaths shewn to exist in other directions will counterbalance any possible error arising under the present head.

The objection has, however, considerable weight, and for this reason in drawing conclusions from the Brighton Life Table (page 17 *et seq.*) the male life table has been chiefly employed.

TABLE I.

Age.	Males. Death-rate per 1000 Males in each group. Brighton, 1881-90.	Males. Death-rate per 1000 Males in each group. England, 1881-85.	Males. Excess or deficiency of Death-rate of Brighton over England per cent.	Females. Death-rate per 1000 Females in each group. Brighton, 1881-90.	Females. Death-rate per 1000 Females in each group. England, 1881-85.	Females. Excess or deficiency of Death-rate of Brighton over England per cent.
0—	64·01	59·6	+ 7·4	52·59	50·5	+ 4·1
5—	4·83	5·8	—16·7	4·45	5·6	—20·5
10—	2·30	3·2	—28·1	2·53	3·3	—23·3
15—	4·13	4·6	—10·2	2·92	4·7	—37·8
20—	5·05	6·0	—15·8	3·44	5·9	—41·7
25—	7·72	8·2	— 5·8	5·42	7·9	—31·4
35—	12·94	12·7	+ 1·9	9·01	10·9	—17·3
45—	21·17	19·4	+ 9·1	14·44	15·2	— 5·0
55—	32·76	33·6	— 2·5	24·36	27·8	—12.3
65—	64·36	68·8	— 6·4	50·93	59·5	—14·4
75—	132·29	144·6	— 8·5	121·92	129·4	— 5·8
85 and upwards	293·80	296·4	— 1·1	266·40	267·8	— 0 7

B.—Method of Construction of a Life Table.

Method of ascertaining Population and Deaths for each Year of Age.—In the construction of a Life Table it is necessary to ascertain the death rate holding good for each year of life in the two sexes. For this purpose we must have an accurate statement of

(1) The population for each year of age; and

(2) The number of deaths occurring during the corresponding year.

These data are not supplied in full for each year either for population or deaths, and we must now discuss the means for interpolating the correct figures for each year of life from the figures furnished in Table II.

TABLE II.

Age.	Population of the Parliamentary Borough of Brighton. Census, 1881. Males.	Females.	Census, 1891. Males.	Females.	Deaths in the Parliamentary Borough of Brighton. 1881-90. Males.	Females.	Age.
0—	7233	7374	7046	7051	4569	3800	0—
5—	6653	6435	7137	7169	333	301	5—
10—	6158	6473	6829	7300	149	174	10—
15—	5258	8069	5882	8600	229	243	15—
20—	5158	8023	4967	9038	256	292	20—
25—	8471	12291	9142	13894	678	709	25—
35—	6260	8889	7308	10411	872	866	35—
45—	4557	6698	5335	7755	1040	1034	45—
55—	3174	4819	3574	5443	1104	1243	55—
65—	1645	2807	2254	3451	1235	1577	65—
75—	663	1041	778	1291	945	1416	75—
85—	76	118	85	221	261	413	85—
95—	3	4	4	5	7	22	95—
Total All Ages	55309	73041	60341	81629	11678	12090	Total All ages
	128350		141970				

(*a*) *To ascertain the total number of lives at risk at each group of ages during the decade 1881-90.*—We must first ascertain the central population in each group by adjusting the figures in Table II. to June 30th.

The formula is $Q = P\ R^{\frac{1}{4}}$ where Q = central population required; P = census population; and R = population resulting per unit per annum. R is first found from the formula $Q = P\ R^{10}$ *

*Value of R for each Age Period.

Age.	Males.	Value of R for each age period.	Females.	Value of R for each age period.	Age.
0 -	$7,046 = 7,233\ R^{10}$	·99738	$7,051 = 7,374\ R^{10}$	·99553	0 -
5 -	$7,137 = 6,653\ R^{10}$	1·00705	$7,169 = 6,435\ R^{10}$	1·0109	5 -
10 -	$6,829 = 6,158\ R^{10}$	1·01040	$7,300 = 6,473\ R^{10}$	1·0121	10 -
15 -	$5,882 = 5,258\ R^{10}$	1·01128	$8,600 = 8,069\ R^{10}$	1·0064	15 -
20 -	$4,967 = 5,158\ R^{10}$	·99623	$9,038 = 8,023\ R^{10}$	1·0120	20 -
25 -	$9,142 = 8,471\ R^{10}$	1·00765	$13,894 = 12,291\ R^{10}$	1·0123	25 -
35 -	$7,308 = 6,260\ R^{10}$	1·01560	$10,411 = 8,889\ R^{10}$	1·0159	35 -
45 -	$5,335 = 4,557\ R^{10}$	1·01590	$7,755 = 6,698\ R^{10}$	1·0148	45 -
55 -	$3,574 = 3,174\ R^{10}$	1·12600	$5,443 = 4,819\ R^{10}$	1·0123	55 -
65 -	$2,254 = 1,645\ R^{10}$	1·03200	$3,451 = 2,807\ R^{10}$	1·0209	65 -
75 -	$778 = 663\ R^{10}$	1·01610	$1,291 = 1,041\ R^{10}$	1·0217	75 -
85 -	$89 = 79\ R^{10}$	1·01200	$226 = 122\ R^{10}$	1·0636	85 -

Next we find Q the central population from $Q = P R^{\frac{1}{4}}$ where P is the census population and R is given in the table in the footnote on page 10. Thus:

$$Q = 7233\ (\cdot 99738)^{\frac{1}{4}}$$
$$\log.\ 7233 = 3\cdot 859318$$
$$\tfrac{1}{4}\log.\ \cdot 99738 = \bar{1}\cdot 999716$$
$$\log.\ Q = 3\cdot 859034$$
$$\therefore Q = 7228 = \text{central male population, 1881, aged 0-5.}$$

The central populations for each census year thus obtained are as follows:—

TABLE III.

1881.			1891.		
Age.	Males.	Females.	Males.	Females.	Age.
0—	7228	7366	7041	7043	0—
5—	6665	6452	7150	7188	5—
10—	6174	6492	6847	7322	10—
15—	5273	8082	5898	8613	15—
20—	5153	8047	4962	9065	20—
25—	8487	12328	9159	13936	25—
35—	6284	8924	7336	10452	35—
45—	4575	6724	5356	7783	45—
55—	3184	4834	3585	5459	55—
65—	1658	2822	2272	3469	65—
75—	666	1046	781	1298	75—
85—	79	124	89	229	85—

Having now ascertained the central population for the two census years 1881 and 1891, we proceed to ascertain the total population for the ten years 1881-90, *i.e.*, the total number of lives subjected to a year's risk of death during this period.

The method by which the value of R has been calculated for each age period is sufficiently indicated in the table (footnote, page 10). In calculating the total population for the years 1881-90, the following method has been adopted. Employing the notation already explained, the population for each year of the decade would be denoted by P, PR, PR^2, &c. . . . PR^9. These amounts give the terms of a geometric series, of which the first term is P and common ratio is R. Hence the total population for the decade is the sum of this series, $P + PR + PR^2 + \&c. + PR^9$, the usual formula for which gives a sum to ten terms $= P\frac{R^{10} - 1}{R - 1} = \frac{PR^{10} - P}{R - 1} =$

$$\frac{\text{Population, 1891} - \text{population, 1881}}{\text{annual increase per unit}}$$

The tables already given supply us with the central population for each census year. Thus in the third age period the male population for 1891 = 6847, and for 1881 it is 6174. The difference is 673. Also for that period R = 1·0104.

Therefore total population $= \frac{673}{\cdot 0104} = 64712$. A similar calculation gives us the results contained in Table IV. for the other age periods.

It is plain that when R is less than unity, the population for 1891 will be less than that for 1881, so that numerator and denominator of the above fraction will always have the same sign.

TABLE IV.

Total Number of Lives at Risk in the Ten Years 1881–90, and Total Number of Deaths during the same period.

Age.	Number of Lives at Risk.		Deaths.		Mean Annual Death-Rate for each life at risk.	
	Male.	Female.	Male.	Female.	Male.	Female.
0 –	71,374	72,259	4,569	3,800	·06401	·05259
5 –	69,236	67,524	333	301	·00483	·00445
10 –	64,712	68,595	149	174	·00230	·00253
15 –	55,408	82,969	229	243	·00413	·00292
20 –	50,663	84,833	256	292	·00505	·00344
25 –	87,843	130,732	678	709	·00772	·00542
35 –	67,436	96,101	872	866	·01294	·00901
45 –	49,119	71,568	1,040	1,034	·02117	·01444
55 –	33,698	51,020	1,104	1,243	·03276	·02436
65 –	19,187	30,957	1,235	1,577	·06436	·05093
75 –	7,143	11,613	945	1,416	·13229	·12192
85 –	878	1,589	261	413	·29726	·25991
95 –	34	44	7	22	·20588	·50000
Total	576,731	769,803	11,678	12,090	·02024	·01575

Note.—The ages are read thus: 0 and under 5, 5 and under 10, 10 and under 15, &c.

(*b*) Having now obtained a statement of the *total number of lives at risk* in quinquennial and decennial groups of ages, the process by which the corresponding numbers *for individual years of life* have been obtained, must be examined. This has been done by an adaptation of the graphic method,

PLATE III.

POPULATION—MALES.

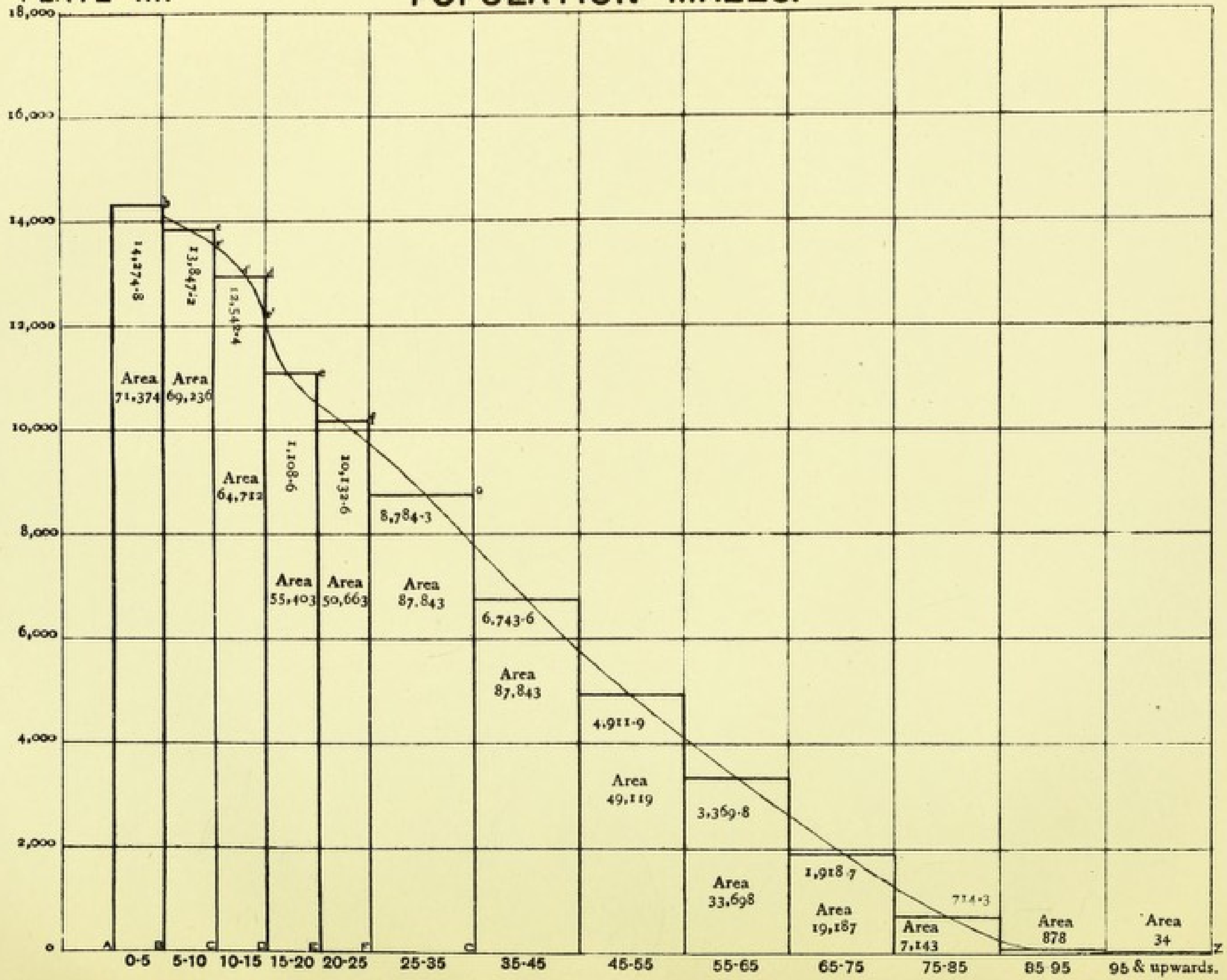
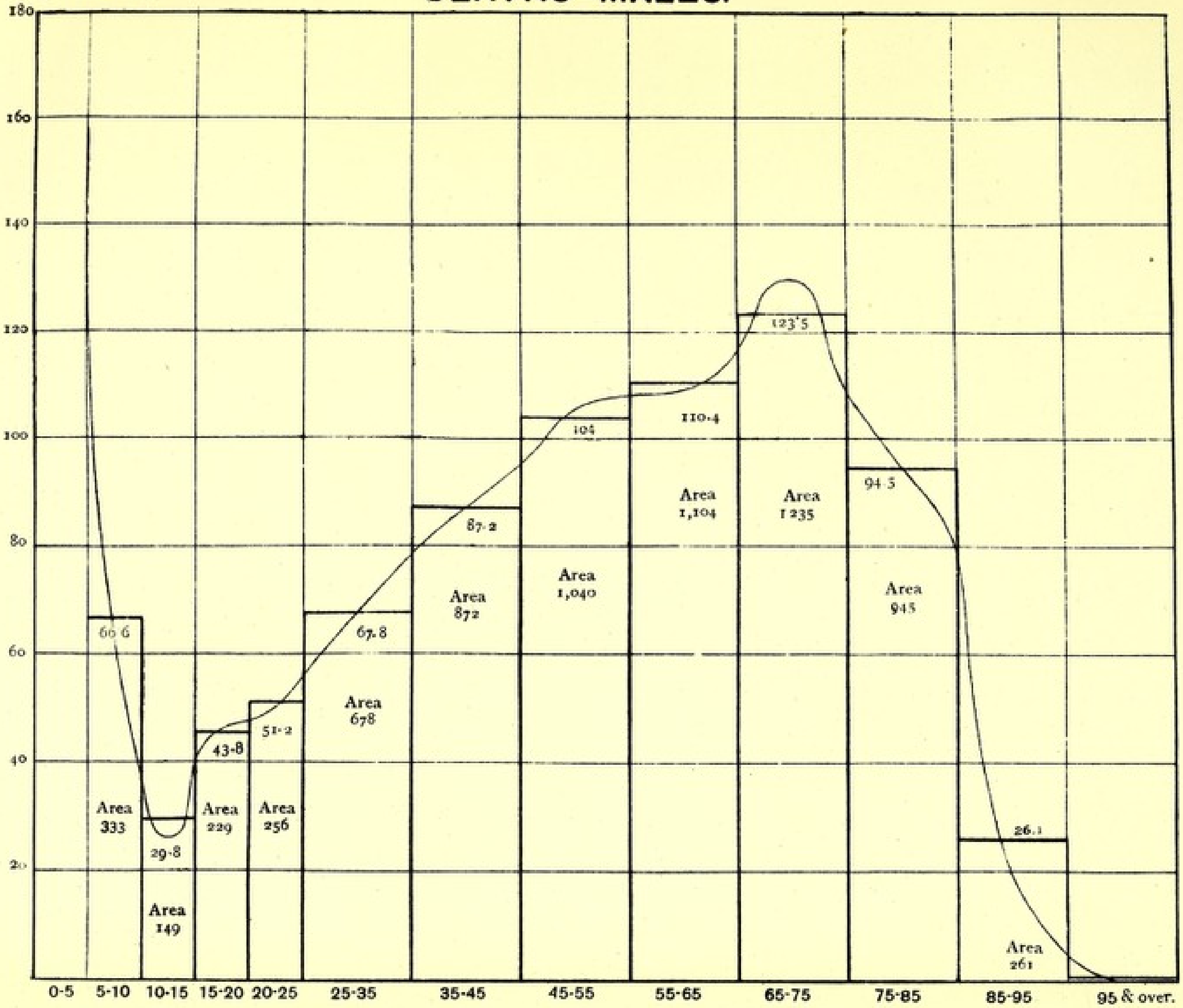


PLATE IV.

DEATHS—MALES.



as described in a paper by Mr. George King, F.I.A., in the Journal of the Institute of Actuaries, No. cxxxi. (Oct., 1883), "On the Method used by Milne in the Construction of the Carlisle Table of Mortality." In this paper Mr. King cleared up the mystery which had hung over the method pursued by Milne in the construction of the Carlisle Life Table, and shewed that the method pursued was a graphical one identical with that here adopted for Brighton.

The method may be briefly described as follows: Along the abscissa line AZ (Plate III.) mark off five equal portions, each to represent five years, for the first five quinquennial intervals of age; and let eight other equal portions, each of double length to represent ten years, succeed them for the subsequent decennial intervals of age.*

At each of the points, A and B, erect perpendiculars to AZ, and make the perpendicular lines of such a height, in accordance with the marginal scale previously decided upon, that the parallelogram A*b* shall equal in dimensions the population living aged 0-5. Thus in the diagram, B*b* = 14274·8, and this when multiplied by 5, the number of years included between A and B, = 71374. Similarly C*c* = 13847·2, and this when multiplied by 5, gives 69236 as the area of B*c*. In the later groups, 10 years are taken. Thus G*g* = 8784·3, the area of F*g* being 87843. Having thus plotted out the populations living at various groups of ages, the number living at each single year of life is obtained as follows:—

A curved line is described through the parallelograms already drawn, sweeping as easily as possible through the upper part of these parallelograms from *A* to *Z*. This curved line (1) must be as little curved as other conditions will admit of. (2) It must never change its direction abruptly so as to form an angle in its path. (3) The curved line thus described must so cut each of the parallelograms that the area included between the base line below, the corresponding portion of the two ordinates laterally, and the portion of the curved line above, shall equal the area of the parallelogram erected on the same base. Thus the area of the parallelogram C*d* = the area of C*c′d′e′*D. In other words the area cut off is exactly equal to the area added.

If now the distances AB, BC, CD, DE, &c., along the abscissa line be divided into equal portions representing one year each, then vertical lines drawn *from the centre of each of these spaces* will give the central population for each year of age.

* Plates III.-VI. have been reduced from the original diagrams, which were constructed on Layton's actuarial paper. This is sub-divided into accurately ruled small squares, thus enabling correct measurement to be made of the perpendiculars representing the number living or the number of deaths at the centre of each year.

The accuracy of the curve is confirmed by ascertaining that the sum of the ordinates drawn from the base line within each space to the curved line bounding the space above is equal to the area of the parallelogram drawn on the same base. Thus in Plate III., $Cd = 64712 =$ the sum of the five ordinates, $13420 + 13220 + 13000 + 12710 + 12372$.*

The accuracy of this method has been demonstrated and illustrated by Mr. George King in the paper already mentioned and in a more recent communication to the Institute of Actuaries on Family Annuities (Journal of the Institute of Actuaries, Vol. XXX., p. 291). The tracing of the curves being effected by a purely graphical process, different draughtsmen may arrive at slightly divergent results. It is, however, impossible that any material discrepancy can thus arise if due care is exercised and if the rules set forth above are rigidly adhered to.

Having described in full the method by which the central population for each year of age is ascertained, it is not necessary to describe the same process for the deaths occurring at groups of ages. A study of Plates III.-VI. and of the description already given will render the method easily intelligible.

The results obtained are set forth in detail in Tables 1 and 2 in the appendix.

Population aged 0-5. The graphic method just described gives accurate results for the greater part of life. The first five years of life, however, give special difficulty whatever method of calculating the central population of each of these years is adopted. This is inseparable from the defective character of the data for these years, the ages of young children being often inaccurately stated in the census returns. Hence, although the number of children at each year of age under 5 can be ascertained from the census returns, these numbers are untrustworthy. The total number aged 0-5 may be accepted as accurate, but the distribution of this total at each age under 5 must be found by an independent method.

The method adopted is based on the births during the decennium. The population under one year of age in any year may be taken as equal to the births from July 1st to December 31st of the preceding year *plus* the births from January 1st to June 30th in the same year, and *minus* the deaths under one year of age during the same year. Similarly the population under one year of age for the ten years 1881-90 may be taken to be equal to the total births 1880½–1889½, *i.e.*, from July 1st, 1880, to June 30th, 1890, *minus* the number of deaths under one year of age in the ten years, 1881-90.

* It is not essential that in every case the sum of the ordinates shall exactly equal the area of the corresponding parallelogram. Occasionally it may be necessary to compensate for excess or deficiency in the neighbouring part of the curve. This is only exceptionally required in order to obtain a good curve.

PLATE V.

POPULATION—FEMALES.

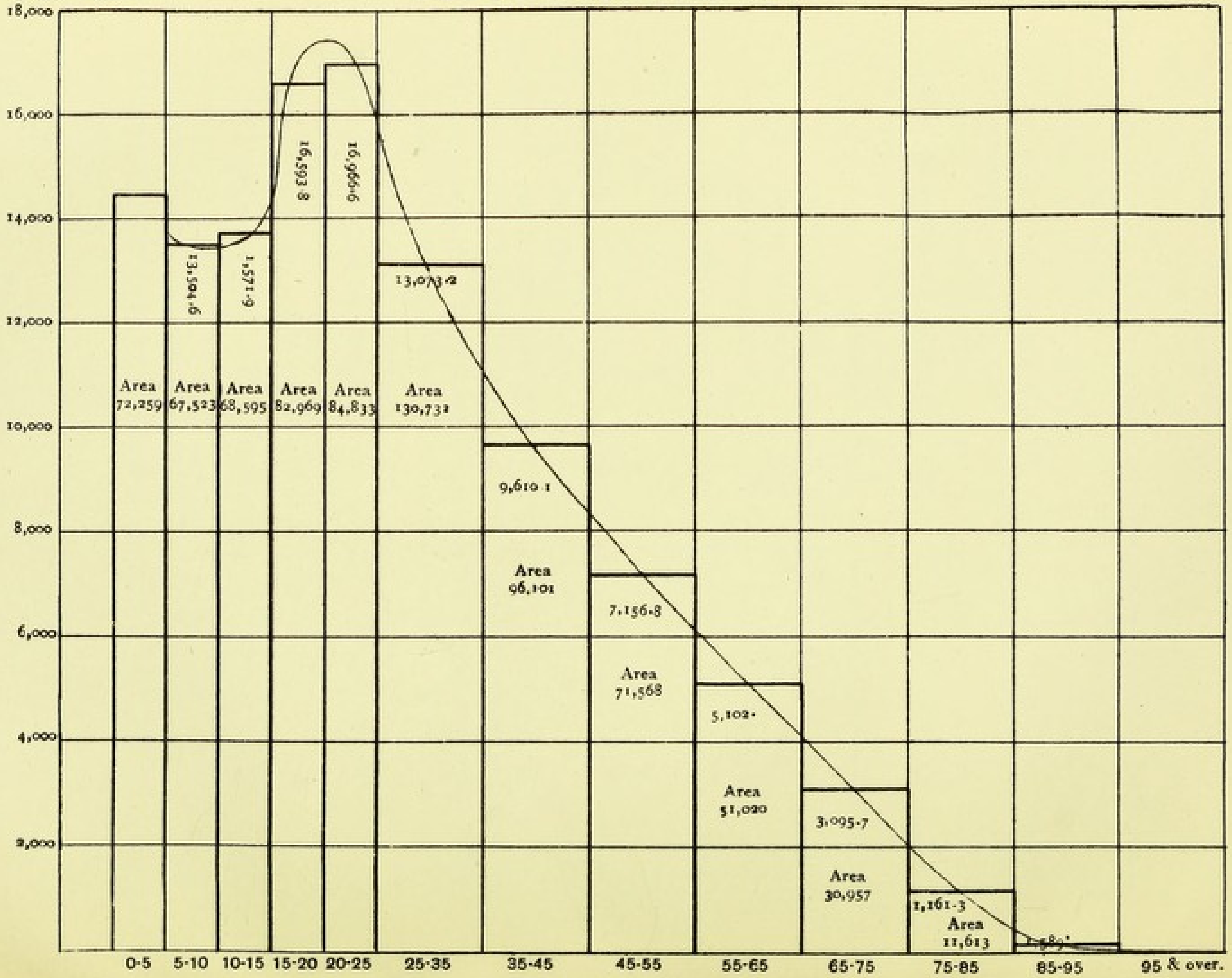
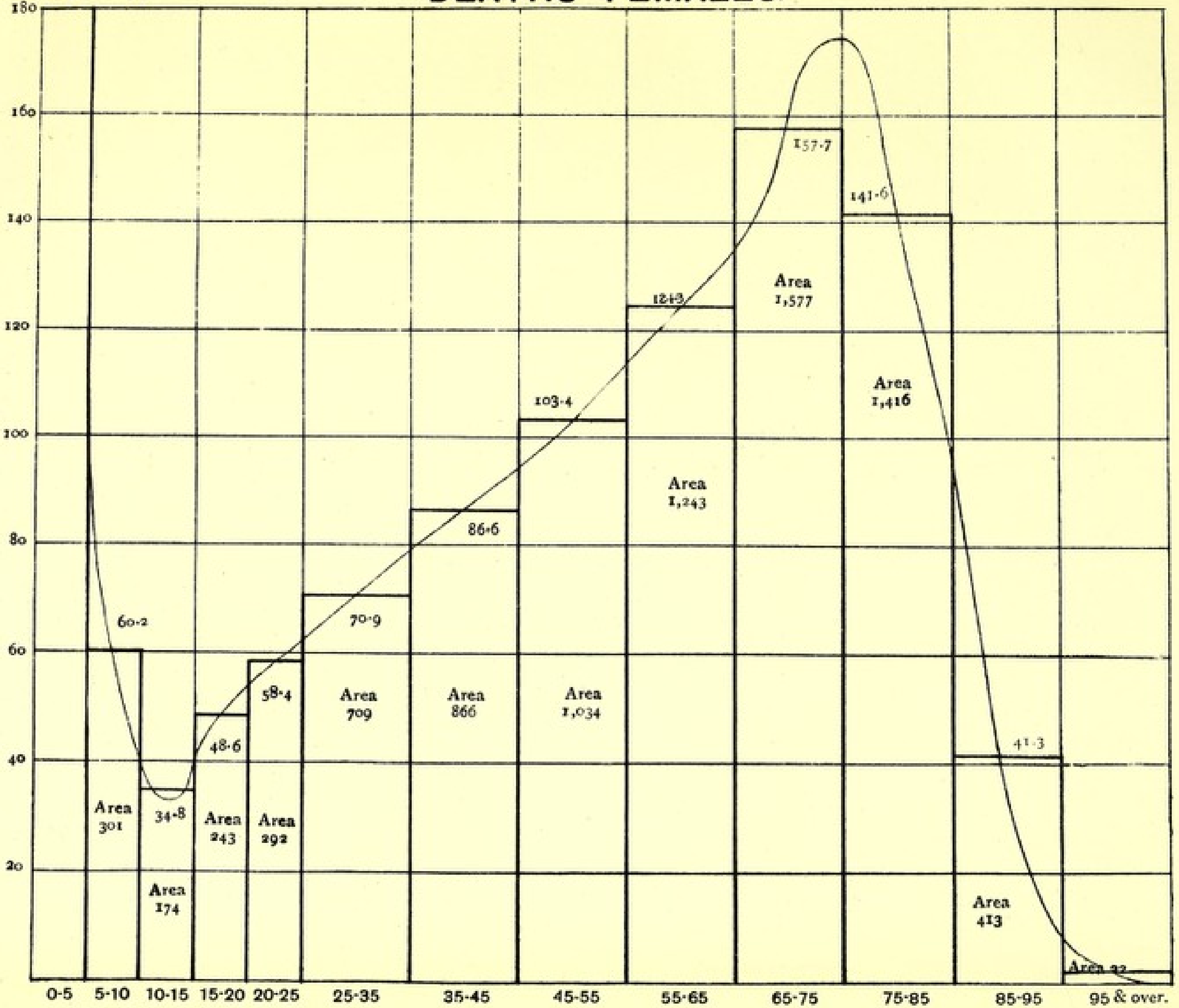


PLATE VI.

DEATHS—FEMALES.



Thus having ascertained the total male births from July 1st, 1880, to June 30th, 1890, and subtracting from the result the total number of deaths of males under one year of age in the ten years 1881-90, we obtain the population out of which the deaths at the age 1-2 occur during the same period. Subtracting the deaths at the age 1-2 we obtain the number out of which the deaths at the age 2-3 occur; subtracting these we obtain the population out of which the deaths at the age 3-4 occur; and subtracting these we obtain the population out of which the deaths 4-5 occur.

The sum of the five amounts thus obtained gives 76627, which is the aggregate population at the commencement of the first five years of life. But when estimated from the census returns it is 71424, the difference being accounted for by migration. Hence these five amounts must each be reduced in the proportion of $\frac{71424}{76627}$.

Having obtained by this means the corrected population at the beginning of each of the first five years of life, we next proceed to obtain the *mean population*, which for each of these years except the first may be taken as the geometrical mean between the population at the beginning of the year (l_x) and at its end (l_{x+1}). In other words the logarithms of the population at the beginning and end of the year are in arithmetical progression. The mean populations thus ascertained are given in Table 1 (Appendix).

The sum of the mean populations for the four years 1-5 is 54,121, and this subtracted from 71,374 gives 17,253 as the mean population of the first year of life.

Construction of the Life Table.—The number of lives at risk at the centre of each year of life and the number of deaths in the corresponding years of life being now known, we obtain by division m_x = the rate of mortality per unit of population, better known to actuaries as the *central death-rate*, because it represents the rate at which people are dying in the *centre* of a given year.

From the m_x column, the probability that a person at each age will survive one full year (p_x) can be obtained.

The probability of living through one year $= \frac{\text{number of survivors at end of year}}{\text{number living at beginning of year}}$;

and by a simple algebraical method it can be shewn (page 227, *Elements of Vital Statistics*), that

$$p_x = \frac{2 - m_x}{2 + m_x}$$

The p_x column calculated from m_x for each age is given in Table 5 (Appendix) separately for the two sexes.

We can now build up the Life Table step by step. It is usual to start with 100,000 children at birth. In Brighton during the ten years 1881-90, the births of male and female children were in the proportion of 51,195 to 48,805, making 100,000 of both sexes. The numbers 51,195 and 48,805 are, therefore, taken as the number at age 0 in the l_x column of Tables 3 and 4 (Appendix).

Starting with 51,195 male infants at birth, the number living at the end of one year is obtained by multiplying this number by the probability of surviving to the end of the first year.

$$\text{Thus } 51{,}195 \times \cdot 84608 = 43{,}315$$
$$43{,}315 \times \cdot 93392 = 40{,}452, \text{ and so on.}$$

In order to obtain the mean expectation of life for each individual it will evidently be necessary to ascertain the total number of years lived by the individuals under consideration and divide the sum by the number of individuals living this total number of years. The l_x column in Tables 3 and 4, gives the necessary data for this calculation.

Thus the 43,315 males surviving to the end of the first year of life out of 51,195 born will have each lived a complete year in the first year, or among them 43,315 years. Similarly 40,452 males will live another complete year each in the second year, or among them a further 40,452 complete years; similarly 39,456 complete years of life will be lived in the third year; 38,723 in the fourth year, and so on, until the males started with become extinct at the age of 105.

It is evident, therefore, that the total number of complete years lived by the 51,195 males started with at birth will be 43,315 + 40,452 + 39,456 + 38,723 + ... 1 = 2,206,174 years. As this number of years is lived by 51,195 males, the number of complete years lived by each male $= \frac{2{,}206{,}174}{51{,}195} = 43 \cdot 09$ years.

This result is known as the *curtate expectation of life.*

We have, in the above remarks, confined our attention to the complete years of life, and have not taken into account that portion of lifetime lived by each person in the year of his death. In some instances this may only be a few days, in others nearly an entire year; but it may be assumed with a fair degree of accuracy, taking one person with another, that the duration of life in the year of death will be half-a-year.

If we add this half-year to the curtate expectation of life, the *Complete Expectation of Life* is obtained.

Thus, the Complete Expectation for males at birth = 43·09 + ·5 = 43·59 years; at the age of 10 years = 48·62 + ·5 = 49·12 years.

In Tables 3 and 4 (Appendix) only the complete expectation of life is printed.

We may note here that the term *mean duration of life* is sometimes used as synonymous with expectation of life (or mean after-lifetime), instead of signifying, as it strictly should, the present age in years *plus* the expectation of life. At birth the two terms are necessarily synonymous. At the age of 40, the expectation of life for males is 25·60 years; the mean duration of life for males of this age = 40 + 25·60 = 65·60 years.

Table 5 (Appendix) is added, in order to enable a comparison to be made of the number of survivors out of 100,000 infants born of each sex at each subsequent age. It has been calculated from the l_x column in Tables 3 and 4 (Appendix).

C.—Deductions from the Brighton Life Table.

Having stated the data on which the Brighton Life Table is based and described the method of its construction, we are in a position to study the life-history of the persons living in Brighton during the decennium 1881-90, on the assumption which the Life Table makes, that they were subjected throughout the whole of their lives to the conditions existing during those ten years.

The three essential points required for such a study will be found in the tables in the appendix, and in the curves which express the same numerical results in a graphic and more easily apprehended manner.

These three points are:

(a) The *mortality per unit of population* (m_x) *or the probability of living one year* (p_x) for each year of life in the two sexes separately. These two functions are closely connected by the formula $p_x = \frac{2 - m_x}{2 + m_x}$ and it has therefore only been considered necessary to print the p_x column in Table 5 (Appendix), with its corresponding curves for the two sexes at each year of age (Plate VII. and VIII.).

Thus at birth the probability of a male child living one year is $\frac{84608}{100,000}$ (the certainty of surviving to the end of the first year of life being taken as unity), and therefore the probability of his dying during the year is $\frac{100,000 - 84608}{100,000} = \frac{15392}{100,000}$. At 25 the probability of a male living one year is $\frac{99403}{100,000}$, and the probability of his dying during the year $\frac{597}{100,000}$ and so on.

(b) The *number of survivors out of 100,000 children born* of each sex, at each succeeding year of life, until the whole number becomes extinct by death.

Table 5 (Appendix) starts with 100,000 boys and 100,000 girls assumed to be born at the same time, and shews how many survivors there would be at the end of each successive year of life, with the death-rates of 1881-90. Thus of 100,000 males born 66979 are still alive at the end of 30 years from birth ; and of 100,000 females born 71750 survive to the same age.

(c) The mean after-lifetime, or expectation of life, of males and females at the end of each year of life.

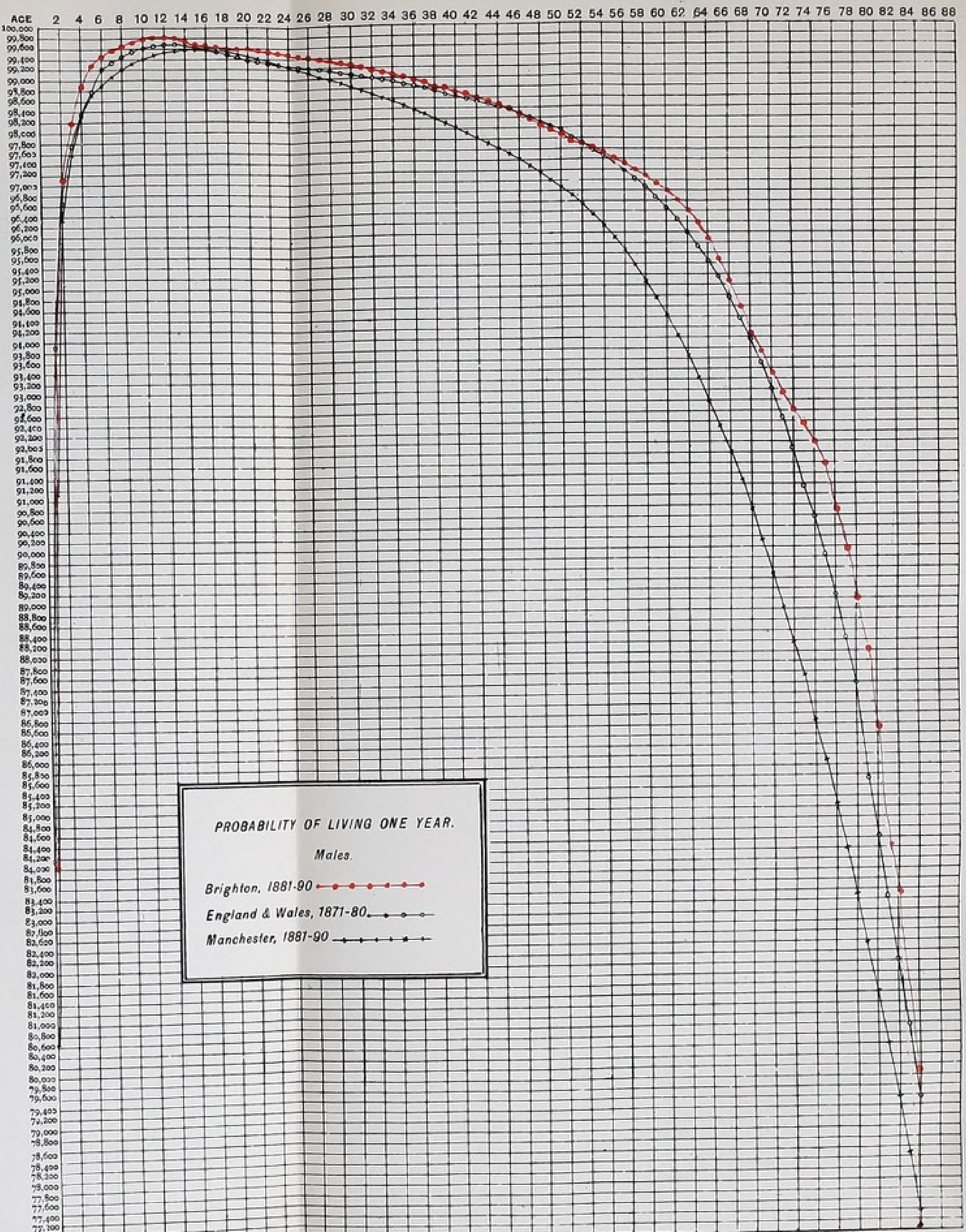
In the last column of Tables 3 and 4 (Appendix) is given the mean expectation of life of males and females at the end of each year of life. Thus for males having just completed their 25th year the mean after-lifetime is 36·51 years, for females of the same age it is 40·48 years.

For any one year of life the first of these *(a)* offers the best test of vitality. The two last—*(b)* and *(c)*—are dependent to some extent on events during preceding and subsequent years of life. Thus in Brighton the number of male survivors out of 100,000 born is greater at each year of age than in England and Wales and still greater than in Manchester. This might, however, be possibly caused by conditions peculiarly favourable to the life of children, which carried over an excess of survivors to older ages, more than sufficient to counterbalance the tendency of any suppositious injurious influences acting upon adults. We know, however, that in fact no such peculiarly favourable or unfavourable forces operate in Brighton. The curves in Plate IX. run smoothly throughout ; but the possibility of the operation of such a disturbing element has to be remembered.

Similarly the expectation of life at any age, being determined by the total number of years of life lived by the persons surviving beyond the given age, might be raised by an exceptionally low mortality at one group of ages, sufficient to more than counterbalance a high mortality at another group of ages. It is evident therefore that although the number of survivors at any given age and the expectation of life at that age are most valuable tests of vitality, they are influenced by the vital conditions of other years of life, unlike the death-rate or the probability of life for a single year. The best plan is to take all three tests into account in instituting comparisons.

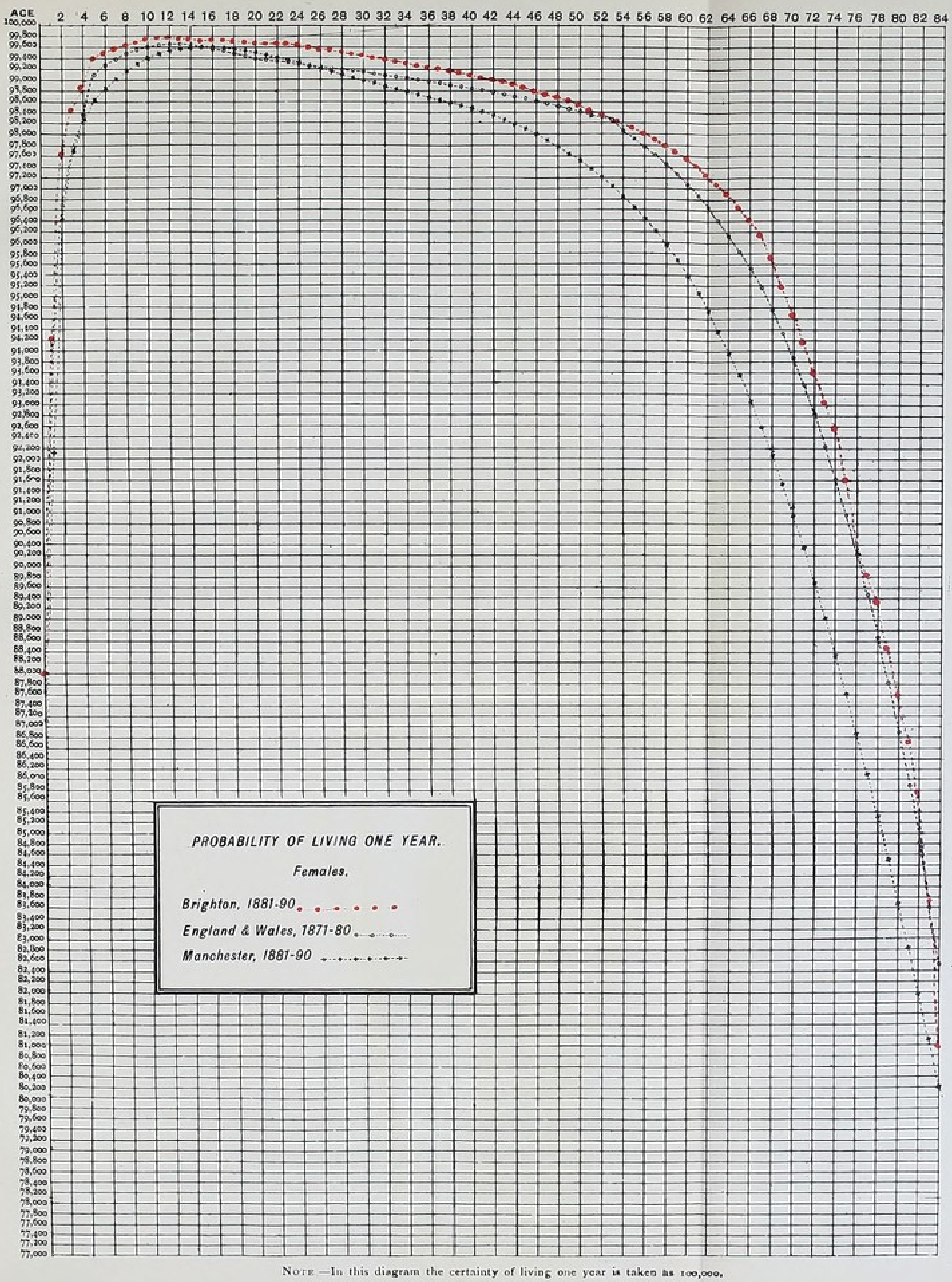
No previous Life Table having been constructed for Brighton, it is impossible to contrast the local vital conditions of 1881-90 with those of any preceding decennium. The value of the present Life Table will be greatly enhanced when ten years hence it becomes practicable by constructing another Life Table to ascertain, by the only strictly accurate method, the probabilities and mean duration of life of the population of Brighton during another decennium and contrast them with those of 1881-90. By this means an

PLATE VII.



NOTE.—In this diagram the certainty of living a whole year is taken as 100,000.

PLATE VIII.



NOTE.—In this diagram the certainty of living one year is taken as 100,000.

exact gauge of the years of life saved by sanitary and other improvements will be obtained.

Such a comparison being at present impossible, we must fall back upon a comparison between the Brighton and other Life Tables. The most recent Life Table for the whole of England and Wales is that for the decennium 1871-80, prepared by Dr. Ogle, the corresponding Life Table for 1881-90 not being yet published. Dr. Ogle's Life Table is therefore used here for comparison with Brighton. Fortunately there is also available for comparison a local Life Table for 1881-90. This is for the City of Manchester, having been prepared by Dr. Tatham, the Medical Officer of Health of that city. Free use is made of this Life Table for purposes of comparison; and the comparison is interesting as shewing the immense difference in the expectation of life in a large and crowded manufacturing centre and in a seaside health resort.*

Comparison of Probability of Life at each Age.—Plate VII. shews that the probabilities of life among males are at most ages greater in Brighton than in England and Wales, the ages 44–53 forming an exception to this rule. Among females the result, as shewn in Plate VIII., is somewhat similar, the probability of life being higher in Brighton than in England and Wales at all ages except 52–54.

Comparison of Number of Survivors at each Year of Age.—It will be seen from Table 5 (Appendix), and graphically in Plate IX., that the number of both male and female survivors out of 100,000 born is greater in Brighton than in England and Wales, and still greater than in Manchester, for practically every year of age until the whole number becomes extinct. The number of survivors among females is greater at each age than among males; but the number of female survivors in Manchester is smaller than the corresponding number of male survivors in England and Wales, and still smaller than the corresponding number of male survivors in Brighton.

The results of the tables in the appendix are summarised in the following tables. It will be seen that in Brighton out of 100,000 male children born, 9,628 more survive to the end of their twenty-fifth year than in Manchester, and 3,565 more than in England and Wales. The period from 25 to 65 years of age embraces the years in which the largest proportion of the work of life is done; it is interesting to note, therefore, that in Brighton

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* Dr. Tatham's valuable Life Table is constructed (like the English Life Table) by the analytical method; the Brighton Life Table by the graphic method. This does not however, invalidate the comparison between them.

out of 100,000 males born, 14,388 more reach the age of 65 than in Manchester and 2,739 more than in England and Wales. This larger number of survivors to the higher ages out of a given number born implies a corresponding increase in the number of years of working life, and forms a sufficient answer to those who assert that the main decrease of mortality in recent years having been in the early years of life, is of doubtful good to the community.

TABLE V.

EXCESS OF SURVIVORS IN BRIGHTON AT EACH AGE OUT OF 100,000 BORN AS COMPARED WITH MANCHESTER AND WITH ENGLAND AND WALES.

Age.	Excess of Survivors out of 100,000 Male Children Born, as compared with		Excess of Survivors out of 100,000 Female Children Born as compared with	
	Manchester, 1881-90.	England and Wales, 1871-80.	Manchester, 1881-90.	England and Wales, 1871-80.
5	7,229	1,718	6,754	2,284
15	9,425	2,859	9,225	3,343
25	9,628	3,565	10,170	4,984
45	12,511	3,938	14,283	7,458
65	14,388	2,739	18,704	7,114
85	2,826	552	4,817	1,706

This table may be read as follows: Out of 100,000 male children born, 7229 or 7·23 per cent. more reach the age of 5 years than in Manchester, and 1718 or 1·72 per cent. more than in England and Wales. Similarly 12·51 per cent. more male children reach the age of 45 years than in Manchester, and 3·94 per cent. more than in England and Wales.

Comparison of Expectations of Life at each Year of Age.—The following tabular statement giving the expectation of life at the end of each five years of life, and Plates I. and II. page 5, giving the expectation of life for each single year of life, shew that in Brighton the expectation of life at birth for males was 43·59 years as compared with 34·71 years in Manchester and 41·35 years in England and Wales. In other words it was 20·4 per cent. higher than in Manchester and 5·1 per cent. higher than in England and Wales. Similarly for females the expectation of life at birth in Brighton was 49·00 years as compared with 38·44 years in Manchester, and 44·62 years in England and Wales, an excess in favour of Brighton of 21·5 and 8·9 per cent. respectively.

PLATE IX.

DIAGRAM SHEWING OUT OF 100,000 CHILDREN BORN ALIVE, THE NUMBER THAT SURVIVE TO EACH OF THE UNDERMENTIONED AGES.

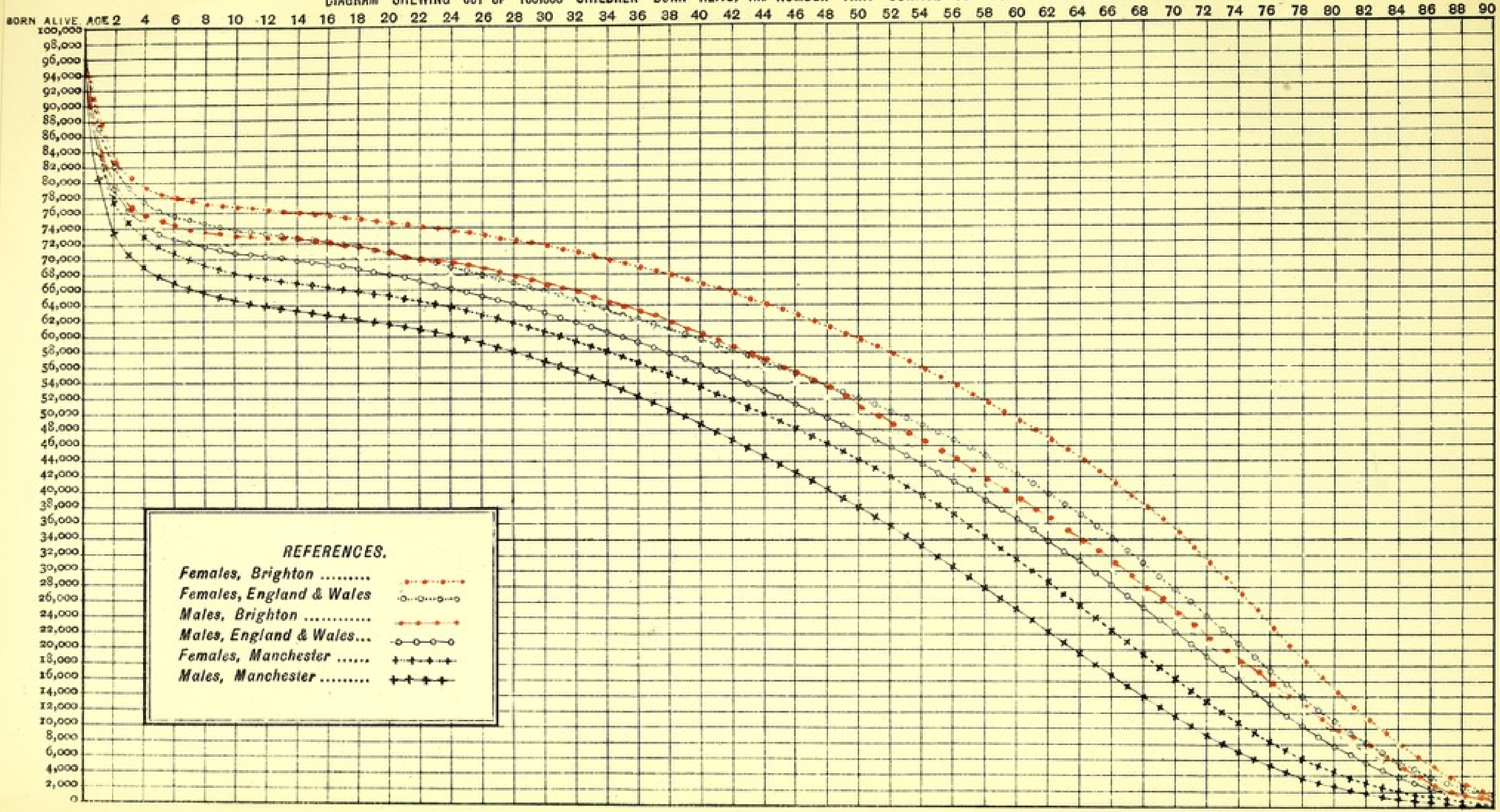

TABLE VI.

Expectation of Life at Various Ages.

Ages.	Males.			Females.		
	Brighton, 1881-90.	Manchester, 1881-90.	England and Wales, 1871-80.	Brighton, 1881-90.	Manchester, 1881-90.	England and Wales, 1871-80.
0	43·59	34·71	41·35	49·00	38·44	44·62
5	52·87	45·59	50·87	56·92	48·06	53·08
10	49·12	42·75	47·60	53·15	45·43	49·76
15	44·67	38·78	43·41	49·07	41·50	45·63
20	40·55	34·62	39·40	44·76	37·33	41·66
25	36·51	30·69	35·68	40·48	33·38	37·98
30	32·67	27·08	32·10	36·39	29·73	34·41
35	29·02	23·76	28·64	32·48	26·30	30·90
40	25·60	20·68	25·30	28·71	22·99	27·46
45	22·36	17·80	22·07	25·07	19·79	24·06
50	19·33	15·06	18·93	21·79	16·74	20·68
55	16·48	12·49	15·95	18·48	13·91	17·33
60	13·67	10·16	13·14	15·26	11·35	14·24
65	10·96	8·15	10·55	12·19	9·11	11·42
70	8·69	6·48	8·27	9·32	7·25	8·95
75	6·64	5·11	6·34	6·97	5·76	6·87
85	3·33	3·16	3·56	3·72	3·76	3·88

We prefer, however, more particularly to compare the expectation of life at the ages of five and upwards, as the data on which the expectation of life at birth and from birth to the age of five years are calculated are not so trustworthy as those for later years. This point has been already discussed (page 14), and it is sufficient to add here that the population data for the first five years of life (owing largely to confusion in the statement of age) are not very trustworthy; that the same causes operate in a minor degree in the registration of deaths under five years of age; and that, although the figures as to the total number living and the total number dying under five years of age may be considered accurate, the exact distribution of these is somewhat dubious.

After the fifth year of age there is greater accuracy in the statement of ages; and the figures, at least for males, may be accepted as opproximately correct. The expectation of life being based on the *subsequent* years of life will not be affected by possible inaccuracies preceding the age under consideration.

Table VI. and Plate I. shew that among males the expectation of life is considerably greater at all ages in Brighton than in Manchester. At the age of 5 the excess is 7¼ years, at the age of ten it is nearly 6½ years, at the age of 20 it remains about 6 years, while at 40 it is 5 years, and at 60 between 3 and 4 years. Compared with England and Wales, the expectation of life among males is just two years greater in Brighton at the age of 5, at the age of 10 about 1½ years, at the age of 20 over one year, at the age of 40 over one-third of a year, and at the age of 60 half a year greater in Brighton.

These satisfactory results may be expressed in another way, as in Table VII.

TABLE VII.

THE PROPORTION OF THE EXPECTATION OF LIFE AT VARIOUS AGE PERIODS IN BRIGHTON TO THAT OF MANCHESTER AND OF ENGLAND AND WALES.

Mean After-lifetime (Expectation of Life) in Manchester (1881-90) and England and Wales (1871-80), Brighton (1881-90) being taken as 100.

Age.	Manchester, 1881-90.		England and Wales, 1871-80.	
	Males.	Females.	Males.	Females.
0	79	78	95	91
5	86	84	96	93
15	87	85	97	93
25	84	82	98	94
45	79	79	98	96
65	74	75	96	94
85	95	101	107	104

Taking the expectation of life in Brighton as 100, then among males at birth it is 79 in Manchester and 95 in England. At the age of 5, it is 100 in Brighton, 86 in Manchester, 96 in England and so on. The male expectation of life remains higher in Brighton than in England, until the age of 77 is reached, when the two are identical, as may be seen by glancing at Plate I.

Share of each Age Period in the Gain of Life.—It has been already shewn that the improved prospects of survivorship at the earlier ages of life imply for the community an increase of the number of years of life during the working period of life. This point must now be more exactly established. Mr. Noel Humphreys* classifying the years of life lived, into those lived 0 – 20, 20 – 60, and 60 and upwards, shewed that by far the larger proportion of the increased duration of life is lived at useful ages (20-60), and not at the dependent ages of childhood or old age. Dr. Tatham in the Manchester Life Table has

* Journal of the Royal Statistical Society. June, 1883.

extended this inquiry, and his classification of age-groups is adopted in Tables VIII. and IX., with a slight modification.

Table VIII. shews the number of years out of the total number of complete years of life, lived during each age-period.

TABLE VIII.

Years Lived out of the Total Mean Lifetime during each Age-period.

Age.	Males.			Females.		
	Brighton.	England and Wales.		Brighton.	England and Wales.	
	1881-90.	1838-54.	1871-80.	1881-90.	1838-54.	1871-80.
0–15	11·21	10·72	10·96	11·62	11·12	11·38
15–25	7·05	6·48	6·76	7·48	6·70	7·02
25–45	12·60	11·18	11·36	13·78	11·51	11·89
45–65	8·85	7·99	8·50	10·61	8·45	9·51
65 & upwards	3·38	3·04	3·27	5·01	3·57	4·32
All Ages	43·09	39·41	40·85	48·50	41·35	44·12

It may be noted in passing that, for the sake of convenience, the curtate expectation of life (less than the complete expectation by half-a-year) is the total lifetime given in the last line of the preceding table; and the number of years in each of the age-periods is the share of this lifetime lived during that age-period. Thus (see Table 3 Appendix) the years of life lived on the average by each male between the ages of 25 and 45 $= \frac{1,271,083 - 625,961}{51,195} = 12·60$ years, and so on.

The table may also be read thus: According to the Brighton experience 100 males live in the aggregate 4,309 complete years of life, of which 1,121 years are lived at ages under 15, 705 at ages 15–25, 1,260 at ages 25–45, 885 at ages 45–65, and 338 at ages 65 and over; and so on.

It is evident, therefore, that 100 males will live in the aggregate 228 more years in Brighton at ages 25–65 according to the experience of 1881–90, than during the same period of life according to the experience of England in 1838–54, and 159 more years than during the same period of life according to the experience of England in 1871–80.

The years lived in each age-period may be stated as a percentage of the total expectation of life, as in the following table. It will be noted, however, that this method will not indicate the fact that the total expectation of life on which the percentage is formed is greater in Brighton than in the others.

TABLE IX.

PERCENTAGE OF TOTAL LIFETIME LIVED IN EACH AGE PERIOD.

Age.	Males.			
	Brighton.	Manchester.	England and Wales.	
	1881-90.	1881-90.	1838-54.	1871-80.
0–15	26·0	29·5	27·2	26·9
15–25	16·4	17·7	16·5	16·5
25–65	49·7	48·6	48·6	48·6
65 and upwards	7·9	4·2	7·7	8·0
	100·0	100·0	100·0	100·0

This table clearly shews that a larger proportion of the total average lifetime is now lived at the years of usefulness, 25–65, than in England and Wales in the past. Hence inasmuch as the total duration of life has been considerably increased, it follows that the number of years lived during the useful period of life has also increased.

A glance at Plates I. and II. will shew that the expectation of life at the higher ages gradually loses its superiority over that for England and Wales ten years earlier, the two curves steadily approximating as age advances.

It is evident therefore that although, owing to the large number of lives saved during the early years of life, the number surviving to the higher ages has increased, thus securing a great gain to the *community*, this is not incompatible with a stationary or even dimished prospect of life for each *individual* over a certain age. In England the death-rate for males was higher in 1871-80 for all age groups above the 25-35 period, and for females was higher in 1871-80 for all age-groups above the 35-45 period than in preceding decennia. The mean expectation of life for males in England was less in 1871-80 for all ages after the 19th year than in 1838-54 (Dr. Farr's English Life Table, No. 3); and for females was less for all ages after the 45th year. At the same time it is true that the number of male survivors was greater in 1871-80 than in 1838-54 up to the end of the 67th year; and the number of female survivors are greater in 1871-80 than in 1838-54 up to the 93rd year.

In Brighton there are indications of a similar state of things, Tables V.-IX. and Plates I., II. and VII.-IX., shewing that the superiority of Brighton over England and Wales becomes much less at the higher ages.

It becomes then interesting and important to enquire, why has the improvement in probabilities of life at the earlier ages not been participated in throughout life?

Why has not the expectation of life improved for ages beyond 20 *in males and* 45 *in females* according to the experience of England and Wales (1871-80), an experience which Brighton probably shared to some extent with the rest of the country?

(1). An initial doubt is thrown by some on the accuracy of the data which shew such a result. It is suggested that with advance of time, the age returns at the census enumerations and in death certificates have become increasingly accurate, and that the increased mortality and diminished expectation of life at the higher ages is the result of this increased accuracy of statement, and, therefore, only apparent. That there is occasional exaggeration in the statement of age at advanced years, and that among females between 20 and 50 there is a not infrequent understatement of age is well known. It cannot, however, be supposed with an appearance of reason that any alteration in the operation of these or like causes will explain the diminished expectation of life at the higher ages in England in 1871-80 as compared with 1838-54.

(2). A favourite explanation of the diminished expectation of life in adult years is that, owing to the saving of life in the earlier years of life—a saving which has been especially in zymotic diseases and phthisis and other tubercular diseases—there has been a larger number of weakly survivors, who would under the former *régime* have been carried off by these diseases. In other words, the operation of the law of the survival of the fittest has been impeded, with results unfavourable to the health and vigour of adult life. This argument assumes that weakly children are more prone to attack by infectious diseases than robust children, an assumption which experience does not confirm. These diseases appear to attack the majority of children, weakly or robust, who are exposed to their infection. It might be reasonably expected, therefore, that with a decrease in the total deaths from infectious diseases, there would have been at least a corresponding decrease in the number of those who are left maimed by an attack of one of these diseases to survive to adult life. We personally think that the weeding out of weakly lives, caused by the greater mortality among weakly children suffering from an infectious disease, is almost entirely counterbalanced by the greater number of children made weakly in former times by non-fatal attacks of an infectious disease.

The case for deterioration of the race by survival of patients who would formerly have died in early life from phthisis and other tubercular diseases, appears to be a stronger one. It is probable that a larger proportion of phthisical patients are cured than formerly. It is probable also that many more children with a strong tendency to phthisis, or even suffering from its early symptoms are prevented by the improved medical treatment and the improved social conditions of recent years, from developing the disease. These now may survive to adult life and become the parents of children with a strong tubercular tendency.

Such a fact need not, however, cause any serious apprehension for two reasons. In the first place, hereditary tendencies to phthisis only act under favourable predisposing conditions, such as damp and overcrowded houses, sedentary occupation in a cramped position, &c. ; and in presence of the active exciting agent, the specific bacillus to which phthisis and other tubercular diseases are due. The exciting cause of tuberculosis is the introduction *ab extra* of the specific infection by inhalation or by means of food.

In the second place, assuming that more phthisical patients survive than formerly, is it not equally true that fewer persons *become* phthisical than formerly? With a diminution of the active cases of phthisis, the number of centres for phthisical sputum, which as dust, is the chief cause of subsequent infection, must have diminished to a corresponding extent. Of the fact that the predisposing causes of phthisis,—damp and overcrowded houses, ill-ventilated workshops, &c.—are steadily diminishing, there is evidence on every hand. It is, therefore, reasonable to suppose that much at least of the deteriorating effect of survival of tubercular persons is counterbalanced by the large number of persons who are *prevented by improved sanitary and social conditions from becoming tubercular.*

It is premature at present to attempt by statistical means to determine how far the counteracting influences which are at work, balance each other, or failing a balance on which side is the preponderating effect.

(3) The increased stress of modern life is supposed by many to explain the increased death-rate among adults. It is doubtful if such increased strain exists in the community as a whole. Each adult as he becomes year by year more deeply involved in the battle of life, comes to the conclusion that the general strain of life in the community is increasing, forgetting that the same causes operated as life advanced in previous generations. There is reason for thinking with Dr. Pye-Smith that much of the evil ascribed to "over-pressure" is really due to over-feeding and drinking.

Assuming, however, that over-pressure exists in certain stations of life, *e.g.*, among city merchants, medical men, &c., it cannot be said to exist generally among professional men. Clergymen, lawyers and civil-servants are as classes long-lived.

Even assuming that over-pressure exists throughout the whole of the professional and mercantile classes, these do not form the mass of the community. *The majority of the population of England and Wales belong to the wage-earning classes*, and the conditions of these classes will therefore necessarily have the greatest influence on the total result. What are the facts as regards these classes? They may be gathered from an important address by Mr. Giffen.* He shews that the wages of the agricultural labourer have increased, while his hours have decreased. In the textile, engineering and house-building trades, he shews that the workman gets from 50 to 100 per cent. more money than 50 years previously for 20 per cent less work. He sums up in the following general statement: "While the workman's wages have advanced, most articles he consumes have rather diminished in price, the change in wheat being especially remarkable, and significant of a complete revolution in the condition of the masses. The increased price in the case of one or two articles—particularly meat and house-rent—is insufficient to neutralise the general advantages which the workman has gained."

The conditions of housing of a large proportion of the wage-earning classes are still unsatisfactory, and leave ample scope for improvement, though they have immensely improved as compared with fifty years ago. It must also be admitted that there is a considerable (though probably a diminishing) residuum who are not included in the general improvement described by Mr. Giffen.

There are two other circumstances affecting the life of the community which must be considered in this connection. These are the effects of increasing "urbanization" and the associated increase of manufacturing (and largely indoor) occupations as contrasted with agricultural and outdoor occupations.

At the census of 1861, 37·7 per cent. of the total population of England and Wales was rural; at the census of 1881, this proportion had decreased to 33·4 per cent., and at the census of 1891 to 28·3 per cent. The urban death-rates are generally higher than the rural, though the former have shewn a greater reduction in recent years than the latter. It is impossible to deny *in toto* that the conditions which go to form the sum-total of urban life are less favourable to a healthy adult existence than those of rural life, though no attempt can be made at present to estimate the share of the increased number of the urban population in say 1871-80 as compared with 1838-54, in producing the higher adult death-rate at the more recent period.

* The Progress of the Working Classes in the last Half-Century, by R. Giffen, F.R.S. (Inaugural Address, Statistical Society, Session 1883-84).

(4) Another consideration requires to be borne in mind. We are at present in a transition period. The Public Health Acts of 1871 and 1875 heralded immense improvements in sanitation, the fruits of which have not even yet been fully reaped. There has been, more especially since 1875, steady and increasing improvement in the conditions under which people live. Men now 40 years of age were born in the pre-sanitary period; and the first 20 years of their life were spent under more unhygienic conditions than those now holding good. This fact would go far towards explaining a stationary death-rate at the higher ages. It does not, however, explain an increased death-rate at those ages.

The explanation of this increased death-rate at the higher ages will probably be evident, when at the end of another 20 or 30 years the improved conditions of life have endured sufficiently long to enable their full force and value to be determined. We must be content in the meantime to have stated the more important factors which appear to be at work, leaving the complete solution of the problem to a time when the statistical experience of our country is more mature.

BRIGHTON LIFE TABLE

(Based on the Mortality of the Ten Years, 1881-90).

TABLE I.

Total Number of Lives at Risk and Deaths for each Year of Age.

MALES.

Age.	Population.		Deaths.	
	In Original Groups.	Distributed.	In Original Groups.	Distributed.
0		17,253		2,877
1		14,001		957
2		13,405		334
3	71,374	13,135	4,569	246
4		13,580		155
5		14,040		100
6		13,970		78
7	69,236	13,870	333	62
8		13,740		51·5
9		13,616		41·5
10		13,420		32·2
11		13,220		27·2
12	64,712	13,000	149	26·2
13		12,710		27·4
14		12,362		36·0
15		11,730		42·3
16		11,300		44·5
17	55,408	11,000	229	46·
18		10,778		47·
19		10,600		49·2
20		10,430		48·2
21		10,300		49·3
22	50,663	10,140	256	50·7
23		9,980		52·8
24		9,813		55·
25		9,620		57·7
26		9,450		60·
27		9,270		62·3
28		9,100		64·7
29		8,903		67·
30	87,843	8,700	678	69·
31		8,500		71·1
32		8,300		73·2
33		8,100		75·5
34		7,900		77·5
35		7,680		80·
36		7,480		81·6
37		7,270		83·2
38		7,050		85·
39	67,436	6,830	872	86·5
40		6,636		88·
41		6,430		89·6
42		6,220		91·1
43		6,020		92·8
44		5,820		94·2
45		5,680		96·5
46		5,500		98·5
47		5,330		101·
48		5,140		103·2
49	49,119	4,990	1,040	105·

TABLE I.

Total Number of Lives at Risk and Deaths for each Year of Age.

MALES—*Continued.*

Age.	Population.		Deaths.	
	In Original Groups.	Distributed.	In Original Groups.	Distributed.
50		4,820		106·
51		4,670		107·
52		4,490		107·2
53		4,320		107·6
54		4,179		108·
55		4,050		108·2
56		3,900		108·4
57		3,730		108·5
58		3,600		108·8
59		3,430		109·3
60	33,698	3,300	1,104	109·7
61		3,138		110·5
62		2,990		111·5
63		2,840		113·3
64		2,720		115·8
65		2,520		118·5
66		2,400		123·
67		2,250		127·5
68		2,110		129·
69	19,187	1,980	1,235	129·5
70		1,850		129·2
71		1,700		128·
72		1,580		124·
73		1,470		116·
74		1,327		110·3
75		1,200		106·5
76		1,060		104·
77		950		101·2
78		840		98·5
79	7,143	750	945	96·0
80		640		93·2
81		530		91·
82		483		88·2
83		380		85·2
84		310		81·2
85		210		70·
86		180		49·
87		130		37·5
88	894	110	261	28·5
89		90		22·
90		70		17·
91		50		13·5
92		30		10·5
93		15		7·5
94		9		5·5
95		9		3·
96	18	5	7	2
97		2		1
98		1		1
99		1		

TABLE 2.

Total Number of Lives at Risk and Deaths for each Year of Age.

FEMALES.

Age.	Population.		Deaths.	
	In Original Groups.	Distributed.	In Original Groups.	Distributed.
0		17,233		2264
1		14,271		846
2	72,259	13,716	3,800	327
3		13,462		207
4		13,577		156
5		13,700		81·
6		13,513		69·2
7	67,523	13,480	301	58·
8		13,410		49·5
9		13,420		43·3
10		13,500		37·2
11		13,560		33·8
12	68,595	13,630	174	33·0
13		13,760		33·5
14		14,145		36·5
15		14,869		43·2
16		16,400		46·4
17	82,969	17,000	243	49·
18		17,300		51·2
19		17,400		53·2
20		17,400		55·3
21		17,340		57·
22	84,833	17,090	292	58·3
23		16,850		59·9
24		16,153		61·5
25		15,450		63·5
26		14,682		65·2
27		14,100		66·8
28		13,700		68·5
29		13,200		70·0
30	130,732	12,700	709	71·6
31		12,300		73·2
32		11,900		75·
33		11,500		76·7
34		11,200		78·5
35		10,900		79·8
36		10,520		81·2
37		10,330		83·
38		9,980		84·2
39	96,101	9,711	866	86·
40		9,400		87·2
41		9,180		89·
42		8,930		90·3
43		8,700		92·0
44		8,450		93·3
45		8,280		95·2
46		7,960		97·0
47		7,750		98·8
48		7,500		100·2
49	71,568	7,300	1,034	101·8
50		7,000		104·
51		6,800		106·

TABLE 2.

Total Number of Lives at Risk and Deaths for each Year of Age.

FEMALES—*continued.*

Age.	Population.		Deaths.	
	In Original Groups.	Distributed.	In Original Groups.	Distributed.
52		6,570		107·5
53		6,308		110·5
54		6,100		113·0
55		6,000		115·2
56		5,820		117·2
57		5,600		119·2
58	51,020	5,400	1,243	121·3
59		5,200		123·3
60		5,010		125·3
61		4,820		127·3
62		4,570		129·3
63		4,400		131·4
64		4,200		133·5
65		3,950		137·
66		3,800		139·5
67		3,617		143·
68		3,370		148·
69	30,957	3,160	1,577	156·
70		3,000		164·
71		2,800		169·
72		2,600		172·
73		2,400		174·
74		2,260		174·5
75		1,900		174·2
76		1,720		172·5
77		1,570		168·
78		1,400		158·
79	11,613	1,210	1,416	148·
80		1,053		139·
81		900		128·
82		760		118·5
83		620		109·8
84		480		101·
85		380		88·
86		300		76·5
87		240		64·
88		180		50·
89	1,589	150	413	40·
90		109		31·
91		90		23·
92		70		18·
93		40		13·
94		30		9·5
95		15		7·
96		8		5·
97	44	6	22	3·8
98		5		2·6
99		4		1·6
100		3		1·
101		2		·6
102		1		·3
103				·1

TABLE 3.

BRIGHTON LIFE TABLE.

(Based on the Mortality of the Ten Years, 1881-90.)

MALES.

Age.	Dying in each Year of Age, 0-1, 1-2, &c.	Born, and Surviving at each Age.	Sum of the Number Living, or Years of Life lived at each Age $x+1$ and upwards to the last Age in the Table.	Mean After Life Time (Expectation of Life) at each Age.
x	d_x	l_x	Σl_{x+1}	$\mathring{e}_x$
0	7,880	51,195	2,206,174	43·59
1	2,863	43,315	2,162,859	50·43
2	996	40,452	2,122,407	52·96
3	733	39,456	2,082,951	53·29
4	440	38,723	2,044,228	53·29
5	272	38,283	2,005,945	52·87
6	211	38,011	1,967,934	52·27
7	169	37,800	1,930,134	51·56
8	141	37,631	1,892,503	50·78
9	114	37,490	1,855,013	49·98
10	90	37,376	1,817,637	49·12
11	77	37,286	1,780,351	48·14
12	75	37,209	1,743,142	47·35
13	80	37,134	1,706,008	46·44
14	108	37,054	1,668,954	45·54
15	131	36,946	1,632,008	44·67
16	145	36,815	1,595,193	43·81
17	153	36,670	1,558,523	43·00
18	159	36,517	1,522,006	42·18
19	169	36,358	1,485,648	41·36
20	167	36,189	1,449,459	40·55
21	156	36,022	1,413,437	39·74
22	178	35,866	1,377,571	38·91
23	189	35,688	1,341,883	38·10
24	198	35,499	1,306,384	37·30
25	211	35,301	1,271,083	36·51
26	221	35,090	1,235,993	35·72
27	234	34,869	1,201,123	34·95
28	243	34,635	1,166,488	34·18
29	259	34,392	1,132,096	33·41
30	265	34,133	1,097,963	32·67
31	279	33,868	1,064,095	31·92
32	298	33,589	1,030,506	31·18
33	309	33,291	997,215	30·45
34	322	32,982	964,233	29·73
35	338	32,660	931,573	29·02
36	351	32,322	899,251	28·32
37	364	31,971	867,280	27·63
38	397	31,607	835,673	26·94
39	393	31,210	804,463	26·28
40	407	30,817	773,646	25·60
41	421	30,410	743,236	24·94
42	437	29,989	713,247	24·28
43	451	29,552	683,695	23·63
44	468	29,101	654,594	22·99
45	484	28,633	625,961	22·36
46	499	28,149	597,812	21·74
47	519	27,650	570,162	21·12
48	540	27,130	543,032	20·52
49	554	26,591	516,441	19·92
50	567	26,037	490,404	19·33
51	590	25,470	464,934	18·75
52	587	24,880	440,054	18·27

TABLE 3.
BRIGHTON LIFE TABLE.
(Based on the Mortality of the Ten Years, 1881-90.)
MALES.—*(Continued).*

Age. x	Dying in each Year of Age, 0-1, 1-2, &c. d_x	Born, and Surviving at each Age. l_x	Sum of the Number Living, or Years of Life lived at each Age $x+1$ and upwards to the last Age in the Table. Σl_{x+1}	Mean After Life Time (Expectation of Life) at each Age. $\overset{\circ}{e}_x$
53	596	24,293	415,761	17·61
54	605	23,697	392,064	17·04
55	608	23,092	368,972	16·48
56	615	22,484	346,488	15·39
57	627	21,869	324,619	14·78
58	633	21,242	303,377	14·22
59	647	20,609	282,768	14·22
60	652	19,962	262,806	13·67
61	668	19,310	243,496	13·11
62	682	18,642	224,854	12·56
63	697	17,960	206,894	12·02
64	720	17,263	189,631	11·46
65	760	16,543	173,088	10·96
66	789	15,783	157,305	10·46
67	826	14,994	142,311	9·99
68	828	14,168	128,143	9·54
69	845	13,340	114,803	9·11
70	842	12,495	102,308	8·69
71	846	11,653	90,655	8·28
72	817	10,807	79,848	7·89
73	758	9,990	69,858	7·49
74	737	9,232	60,626	7·16
75	722	8,495	52,131	6·64
76	727	7,773	44,358	6·21
77	713	7,046	37,312	5·79
78	702	6,333	30,979	5·39
79	677	5,631	25,348	5·00
80	673	4,954	20,394	4·62
81	676	4,281	16,113	4·27
82	590	3,605	12,508	3·97
83	608	3,015	9,493	3·65
84	657	2,407	7,086	3·44
85	529	1,850	5,236	3·33
86	316	1,321	3,915	3·46
87	254	1,005	2,910	3·39
88	168	751	2,159	3·37
89	127	583	1,576	3·20
90	99	456	1,120	2·95
91	85	357	763	2·64
92	81	272	491	2·31
93	76	191	300	2·07
94	46	115	185	2·11
95	25	69	116	1·68
96	15	44	72	1·64
97	12	29	43	1·48
98	7	17	26	1·53
99	4	10	16	1·60
100	2	6	10	1·66
101	1	4	6	1·50
102	1	3	3	1·00
103	1	2	1	·50
104	0	1	0	
105		0		

TABLE 4.
BRIGHTON LIFE TABLE.
(Based on the Mortality in the Ten Years 1881-90.)
FEMALES.

Age. x	Dying in each Year of Age, 0-1, 1-2, &c. d_x	Born and Surviving at each Age. l_x	Sum of the Number living or Years of Life lived at each age $x+1$ and upwards to the last age in the table. Σl_{x+1}	Mean After-Lifetime (Expectation of Life) at each Age. $\mathring{e}_x$
0	6,017	48,805	2,362,354	49·00
1	2,464	42,788	2,319,566	54·71
2	946	40,324	2,279,242	57·03
3	600	39,378	2,239,864	57·38
4	444	38,778	2,201,086	57·26
5	228	38,334	2,162,752	56·92
6	195	38,106	2,124,646	56·25
7	164	37,911	2,086,735	55·54
8	139	37,747	2,048,988	54·78
9	121	37,608	2,011,380	53·98
10	103	37,487	1,973,893	53·15
11	93	37,384	1,936,509	52·30
12	91	37,291	1,899,218	51·43
13	91	37,200	1,862,018	50·55
14	96	37,109	1,824,909	49·68
15	108	37,013	1,797,896	49·07
16	105	36,905	1,760,991	48·22
17	106	36,800	1,724,191	47·35
18	109	36,694	1,687,497	46·48
19	112	36,585	1,650,912	45·62
20	116	36,473	1,614,439	44·76
21	120	36,357	1,578,082	43·90
22	114	36,237	1,541,845	43·04
23	129	36,123	1,505,722	42·18
24	137	35,994	1,469,728	41·33
25	148	35,857	1,433,871	40·48
26	159	35,709	1,398,162	39·65
27	168	35,550	1,362,612	38·83
28	177	35,382	1,327,230	38·01
29	188	35,205	1,292,025	37·20
30	197	35,017	1,257,008	36·39
31	207	34,820	1,222,188	35·60
32	219	34,613	1,187,575	34·81
33	229	34,394	1,153,181	34·03
34	239	34,165	1,119,016	33·25
35	248	33,926	1,085,090	32·48
36	259	33,678	1,051,412	31·72
37	268	33,419	1,017,993	30·66
38	279	33,151	984,842	30·19
39	289	32,872	951,970	29·46
40	291	32,583	919,387	28·71
41	312	32,292	887,095	27·97
42	322	31,980	855,115	27·24
43	333	31,658	823,457	26·44
44	344	31,325	792,132	25·79
45	354	30,981	761,151	25·07
46	375	30,627	730,524	24·35
47	383	30,252	707,272	23·88
48	397	29,869	677,403	23·18
49	408	29,472	647,931	22·48
50	429	29,064	618,867	21·79
51	457	28,635	590,232	21·18
52	458	28,178	562,054	20·44

TABLE 4.

BRIGHTON LIFE TABLE.

(BASED ON THE MORTALITY IN THE TEN YEARS 1881-90.)

FEMALES.—*(Continued).*

Age. x	Dying in each Year of Age, 0-1, 1-2, &c. d_x	Born and Surviving at each Age. l_x	Sum of the Number living or years of Life lived at each age $x+1$ and upwards to the last age in the table. Σl_{x+1}	Mean After-Lifetime (Expectation of Life) at each Age. $\overset{\circ}{e}_x$
53	483	27,720	534,334	19·78
54	500	27,237	507,097	19·15
55	509	26,737	480,360	18·48
56	523	26,228	454,132	17·81
57	542	25,705	428,427	17·16
58	559	25,163	403,264	16·52
59	576	24,604	378,660	15·89
60	594	24,028	354,632	15·26
61	612	23,434	331,198	14·63
62	639	22,822	308,376	14·01
63	653	22,183	286,193	13·40
64	673	21,530	264,663	12·79
65	733	20,857	243,806	12·19
66	726	20,124	223,682	11·61
67	752	19,398	204,284	11·03
68	706	18,646	185,638	10·45
69	864	17,940	167,698	9·84
70	909	17,076	150,622	9·32
71	937	16,167	134,455	8·81
72	976	15,230	119,225	8·32
73	998	14,254	104,971	7·86
74	986	13,256	91,715	7·42
75	1,076	12,270	79,445	6·97
76	1,069	11,194	68,251	6·59
77	1,029	10,125	58,126	6·24
78	972	9,096	49,030	5·89
79	937	8,124	40,906	5·54
80	890	7,187	33,719	5·19
81	835	6,297	27,422	4·85
82	790	5,462	21,960	4·52
83	760	4,672	17,288	4·20
84	745	3,912	13,376	3·92
85	658	3,167	10,209	3·72
86	568	2,509	7,700	3·57
87	457	1,941	5,759	3·46
88	352	1,484	4,275	3·38
89	267	1,132	3,143	3·27
90	216	865	2,278	3·12
91	147	649	1,629	3·00
92	115	502	1,127	2·74
93	109	387	740	2·41
94	80	278	462	2·16
95	74	198	264	1·83
96	60	124	140	1·63
97	32	64	76	1·69
98	15	32	44	1·87
99	6	17	27	2·08
100	4	11	16	1·95
101	2	7	9	1·79
102	2	5	4	1·30
103	2	3	1	·83
104	1	1	0	
105	0	0		

TABLE 5.

PROBABILITY OF LIFE AT EACH AGE, AND NUMBER OF SURVIVORS OUT OF A GIVEN NUMBER BORN.

Age.	The Probability of Living One Year. p_x		Number of Survivors at each Year of Age out of 100,000 at Birth.	
	Males.	Females.	Males.	Females.
0	·84608	·87672	100,000	100,000
1	·93392	·94242	84,999	87,672
2	·97538	·97654	79,380	82,623
3	·98144	·98478	77,425	80,685
4	·98863	·98857	75,987	79,457
5	·99290	·99405	75,125	78,546
6	·99445	·99489	74,590	78,079
7	·99554	·99569	74,176	77,680
8	·99626	·99632	73,845	77,343
9	·99696	·99678	73,569	77,059
10	·99761	·99726	73,344	76,811
11	·99795	·99751	73,168	76,601
12	·99799	·99758	73,017	76,409
13	·99785	·99756	72,869	76,222
14	·99709	·99743	72,713	76,037
15	·99646	·99710	72,501	75,839
16	·99607	·99718	72,242	75,619
17	·99583	·99712	71,958	75,404
18	·99564	·99704	71,659	75,187
19	·99537	·99694	71,346	74,962
20	·99539	·99683	71,015	74,733
21	·99523	·99672	70,687	74,496
22	·99501	·99659	70,380	74,249
23	·99472	·99645	70,031	74,015
24	·99442	·99620	69,661	73,752
25	·99403	·99589	69,273	73,470
26	·99368	·99557	68,858	73,168
27	·99330	·99528	68,425	72,740
28	·99296	·99501	67,966	72,497
29	·99249	·99468	67,489	72,134
30	·99222	·99438	66,979	71,750
31	·99177	·99406	66,460	71,340
32	·99112	·99373	65,913	70,916
33	·99072	·99335	65,328	70,466
34	·99023	·99302	64,722	69,976
35	·98964	·99271	64,090	69,508
36	·98915	·99231	63,426	69,000
37	·98862	·99200	62,724	68,469
38	·98745	·99160	62,009	67,921
39	·98743	·99123	61,230	67,349
40	·98682	·99108	60,459	66,756
41	·98616	·99035	59,661	66,159
42	·98545	·98993	58,834	65,521
43	·98477	·98943	57,978	64,861
44	·98394	·98902	57,093	64,179
45	·98311	·98857	56,175	63,475
46	·98229	·98776	55,224	62,748
47	·98123	·98734	54,246	61,980
48	·98012	·98670	53,291	61,195
49	·97917	·98615	52,168	60,383
50	·97825	·98525	51,081	59,547
51	·97685	·98404	49,969	58,668
52	·97641	·98377	48,811	57,731

TABLE 5.—*continued.*

Age.	The Probability of Living One Year. p_x		Number of Survivors at each Year of Age out of 100,000 at Birth.	
	Males.	Females.	Males.	Females.
53	·97546	·98258	47,660	56,792
54	·97448	·98164	46,490	55,803
55	·97369	·98098	45,303	54,779
56	·97264	·98007	44,110	53,735
57	·97133	·97894	42,904	52,663
58	·97023	·97780	41,674	51,552
59	·96863	·97659	40,432	50,403
60	·96733	·97529	39,163	49,228
61	·96541	·97393	37,884	48,011
62	·96342	·97202	36,573	46,756
63	·96123	·97057	35,236	45,448
64	·95831	·96876	33,868	44,109
65	·95406	·96487	32,455	42,731
66	·95003	·96395	30,964	41,229
67	·94490	·96123	29,417	39,651
68	·94019	·95703	27,796	38,114
69	·93667	·95183	26,172	36,670
70	·93260	·94679	24,514	34,904
71	·92739	·94141	22,862	33,046
72	·92437	·93596	21,202	31,131
73	·92415	·93003	19,599	29,136
74	·92014	·92566	18,112	27,095
75	·91501	·91233	16,666	25,080
76	·90642	·90449	15,250	22,881
77	·89888	·89843	13,823	20,696
78	·88922	·89317	12,425	18,595
79	·87971	·88473	11,048	16,588
80	·86426	·87617	9,720	14,675
81	·84192	·86722	8,399	12,861
82	·83269	·85535	7,073	11,156
83	·79842	·83731	5,915	9,543
84	·76841	·80961	4,723	7,991
85	·71428	·79245	3,630	6,469
86	·76039	·77383	2,592	5,126
87	·74790	·76470	1,972	3,966
88	·77602	·76274	1,473	3,001
89	·78218	·76470	1,144	2,289
90	·78340	·75100	895	1,749
91	·76211	·77379	701	1,324
92	·70213	·77215	534	1,024
93	·60000	·72043	375	789
94	·60000	·71366	226	567
95	·63636	·62162	135	404
96	·66666	·52380	86	253
97	·60000	·51898	57	131
98	·60000	·54076	34	65
99	·60000	·66666	20	35
100			12	23
101			8	14
102			6	10
103			4	6
104			2	2
105			0	0