§ 4. Methods of Measuring Rates of Mortality.

1. **General.**—For the purpose of measuring the rates of mortality experienced by any community, various methods of computation have been employed, which differ materially in the labour involved on the one hand, and on the other in the degree to which they suitably measure the phenomenon in question, viz., the rate at which the members of the community are dying.   In this connection it may be noted that, as regards the methods indicated hereunder, it is not correct to describe any of them as erroneous, as is occasionally done.   So long as these rates are based upon the actual data, one is quite as correct as another ; where they differ is that, whilst one may be very suitable for comparisons with similar rates for other communities, others may be less suitable, and others again quite unsuitable.   Thus the " crude death rate " which represents the ratio of the deaths of both sexes for a given period to the mean population of both sexes for that period is perfectly correct as long as the number of deaths and the mean population are accurately determined, and the division of the former by the latter is properly performed.   It may also be suitable for some purposes, such, for example, as in a question involving the rate of decrement of a given population at a given time.   But it is not suitable for a purpose to which it is very frequently applied, viz., to furnish a basis of comparison in respect of mortality between two communities whose populations are differently constituted in respect of sex, age, and other characteristics, or between two experiences of the same community separated by a lapse of time in which the constitution of the population has characteristically changed.

It must, however, be borne in mind that all methods of determining rates of mortality, whatever degree of refinement may have been introduced into them, consist in ultimate analysis of the determination of ratios of deaths to population.   What is done in the more refined cases is to subdivide both the population and the deaths into like categories according to sex, age, occupation, conjugal condition, &c., and then to determine for each category the ratio of deaths to population.   It will be convenient to review briefly the methods which have been adopted under various circumstances for measuring the rate of mortality.   The principal of these are six in number, as follows :—

(a) The computation of a crude rate for the sexes combined.
(b) The computation of a death rate for each sex separately.
(c) The determination of the average age at death.
(d) The calculation of death rate corrected for sex and age.
(e) The calculation of an index of mortality.
(f) The construction of a life table.

2. **Crude Rate for Sexes Combined.**—Probably the simplest measure of mortality, and that which first suggests itself, is the computation of the proportion of the whole population which has passed away by death during a given period.   Where two communities are similarly constituted in respect of sex and age, this crude rate furnishes a useful and simple index to the relative salubrity of their climate and conditions of life. Similarly in a community which had changed little in the sex and age constitution of its population over a series of years, the crude rate would furnish a valuable index to the progress or retrogression of the community from a sanitary point of view.   Such conditions, however, rarely exist in practice.   Communities usually differ too markedly from each other and from their past selves in respect of sex and age constitution to render comparisons based on crude rates more than rough guides to tendencies which need to be analysed by more refined methods.

3. **Death Rate for each Sex.**—Where data in respect both of deaths and population are available for the sexes separately, one of the disadvantages of the crude rate may be overcome by computing two rates, one for each sex.   In practically all communities there is a marked difference not only in the physical constitution of the sexes, but also in the conditions under which they live, in the nature of their ordinary occupations, and in the special risks incurred by them.   It is consequently not a matter for surprise

that there should usually be a very marked difference between the rates of mortality experienced by them. In most civilised communities longevity is more marked amongst females than amongst males, the female death rate being lower than the male at nearly all ages. Apart, therefore, from the question of a comparison with the experience of other communities, it appears desirable, wherever practicable, to segregate males and females for the calculation of mortality rates. To combine them gives a rate which is applicable to neither the one nor the other. The subdivision according to sex, however, eliminates one of the advantages possessed by the crude rate, viz., that being a single number it is readily quoted and easily compared. A rate for each sex is not so manageable. There are two numbers to quote, and if in a comparison with another community the rate for one sex predominates in the one community, and the rate for the other sex in the other, it is not always easy to draw a conclusion as to relative salubrity.

4. **Average Age at Death.**—A method of estimating salubrity which at an early date in the history of vital statistics had considerable vogue was that of determining the average age at death. Off-hand it might be thought that a high average age at death was a sure sign of longevity and consequently of salubrity. A little reflection, however, will shew that everything depends on the ages of the living. For example, a community in which there were no births, arrivals or departures would shew, under normal conditions, an increasing average age at death as it gradually wore down, while a thriving community with a high and increasing birth rate whould shew a decreasing average age at death ; yet it would be quite possible for the latter to be much more healthy than the former. Here again it may be noted that there is nothing erroneous in computing the average age at death, but an error arises when the conclusion is drawn that a high average age at death necessarily denotes a high degree of salubrity. The method is one which is now practically obsolete as an estimate of salubrity, but, as furnishing in respect of some disease the age incidence of death, it may conveniently and legitimately be employed. For example, statistics of the average age at death from phthisis indicate that it is a disease usually fatal in early adult life, while similar statistics of the average age at death from cancer indicate that the victims are usually of more advanced age.

5. **Death Rate Corrected for Sex and Age.**—Where a number of communities is concerned, and it is desired to effect comparisons between them in respect of mortality, a mode of operation has been devised which, by providing a correcting factor based on age and sex for application to the ordinary crude rate, retains the simplicity of the crude rate while eliminating some of its inherent defects. This method has been most extensively employed in England, where the Registrar-General of England and Wales has supplied in his annual summaries since 1883 a series of corrected death rates for the principal English towns. The first step in calculating the desired correction factors is that of computing for each town a " standard death rate." To obtain this, the average death rates per annum in age-groups for each sex are determined for England and Wales for the whole of an intercensal period. These death rates on being applied to the sex and age distribution for a town, as ascertained at the most recent Census, give the total number of deaths that would have arisen in the town if the average rates for England and Wales had operated therein for a year on a mean population distributed as regards sex and age in the same manner as the population of the town was distributed at the date of the Census. The division of this total number of deaths by the total Census population of the town furnishes the " standard death rate " for the town. The ratio of the crude rate for England and Wales for the whole of an intercensal period to the " standard " death rate of a town for the terminal Census of the period is the town's " factor for correction " for age and sex contribution, and is applied to the crude rate determined for the town in the ordinary way during the ensuing intercensal period. Since the correction factor for any community is determined once only for each intercensal period, and when determined is applied simply as a multiplier to the crude rate for the community, for any year or other period, it is clear that it furnishes a very convenient means for taking into account the sex and age constitution. Also, if the age groups on which it is based are not too comprehensive, for example, not larger than quinquennial, or at the outside, decennial groups, and if it can safely be assumed that the sex and age distribution of the community does not during the ensuing intercensal period deviate markedly from the Census results, the application of the correction factor supplies a very reliable indication of relative salubrity.

6. Index of Mortality.—The method of procedure outlined in section 5 consists in the main in (a) the computation of a normal series of death rates for sex and age; (b) the application of such a series successively to the actual sex and age distributions of the various communities under consideration; (c) the calculation of the crude rate resulting from the application mentioned in (b); and (d) the computation from (c) of a correction factor. Another method which is much in vogue, and which has been approved by the International Statistical Institute, is in some respects the converse of this. It consists in (a) the determination or selection of a population norm, i.e., of a normal scale of distribution of population according to sex and age; (b) the computation for the community under review of death rates for sex and age-groups corresponding to those adopted for the population norm; (c) the application of the rates in (b) to the norm in (a); and (d) the calculation of the crude rate resulting from the application mentioned in (c). The crude rate so obtained is usually called the " index of mortality," or, in the case of the Registrar-General of England and Wales, the " rate in standard population." Where the data for computing the rates of mortality for the appropriate sex and age-groups are readily available, this method furnishes one of the most satisfactory indications of relative salubrity that have yet been described. In essence it consists in computing for a normal population the crude death rate that would arise therein from the operation of the death rates for sex and age-groups ascertained to have operated for the community under review during a given period. From another point of view it is a weighted mean of the death rates for sex and age-groups of the community under review, the weights employed being the appropriate portions of the population norm. The principal difficulty in connection with the computation of the index of mortality for any postcensal period is that of distributing the population of any community for such period according to sex and age. An assumption usually made is that the scale of distribution is the same as that disclosed at the preceding Census. For some communities such an assumption involves little error, in others the discrepancy may be large, but there are no simple means for obviating it. In any event the indications of relative salubrity furnished by such an index or by the corrected rates dealt with in section 5 are much more reliable than can be got by crude rates, rates for sexes, or average ages at death. It may be noted here that although the only characteristics which are dealt with in the ordinary course in computing correcting factors or indices of mortality are sex and age, these are by no means the only ones whose neglect may vitiate conclusions as to relative salubrity. For example, the effect of race on death rate has not yet been definitely determined, but there is little doubt that the variation with age of the death rate amongst European races on the one hand, and coloured races on the other, is essentially different. To institute comparisons, therefore, between mixed populations such as those of the United States, the Union of South Africa, and British India, where European and coloured races are associated in such markedly different proportions, it is not sufficient merely to allow for sex and age, race also should be taken into account.

7. Life Tables.—In connection with the measures of mortality dealt with in sections 5 and 6 above, it may be noted that from one point of view each consists in the determination of ratios of deaths to population for sex and age-groups, and the subsequent computation of a weighted mean death rate. From another point of view each consists of the computation of a series of death rates for one population, and the application thereof to another population, the correction factor method involving the computation of standard death rates and the application thereof to variable population distributions, while the index of mortality method involves the computation of death rates in sex and age-groups for populations varying in sex and age distribution, and the application thereof to a population norm, or population of standard distribution. A further method for measuring mortality is that of constructing a Life Table for the population in question. Here again the main element is the ratio of deaths to population for sex and age-groups, but in this case there is no adoption of an arbitrary standard either of death rates or of population distribution. What is done is to arbitrarily select any number as the number of children born, and by the successive application thereto of death rates for sex and age derived from the experience of the community under observation, to compute the number who will attain each successive age, on the supposition that the computed rates for each age operate at the appropriate ages throughout the lifetime of the children so selected. A table so constructed, however, shewing the number of each sex surviving at each age out of a given number born, is no more convenient for

the purposes of quotation or of ready comparison with other experiences than is the original series of death rates for sex and age on which the table of survivors has been based. The latter, however, presents, in a convenient form, data for the computation of a measure of mortality which is convenient for the purposes of both quotation and comparison. The measure referred to is what is generally known as the " expectation of life," or the " average future lifetime." Of these expressions the former is the more generally used, but the latter expresses the nature of the function in the better way. What is represented by the expectation of life at any age is the average future life time of the persons who reach the age, and are subject at succeeding ages to the rates of mortality deduced from the experience under review. The expectation of life at age 0, consequently, since it represents the average quantity of life that will be lived by each person born, furnishes as suitable a measure of relative salubrity as could be devised, and one which is entirely free from the introduction of an arbitrary standard whether of death rates or population distribution. It necessarily relates, however, only to a completed period, and consequently will not serve the purpose of providing comparative results for a current period. For this latter purpose the correction factor and the index of mortality furnish the best results.

In Year Book No. 11, pp. 236–242, are given tables shewing some of the principal results furnished by the Australian Life Tables, 1881–90, 1891–1900, and 1901–10.

§ 5. Graphical Representation of Vital Statistics.

1. **General.**—The progressive fluctuations of the numbers representing the total births and marriages are important indexes of the economic conditions and social ideals of a community. For this reason graphs have been prepared (see pages 211 and 212), shewing these fluctuations from 1860 to 1918, both for the States and the Commonwealth. The facts are very significant from the national point of view, and call for serious consideration. To appreciate the situation properly, it should be remembered that, normally, the increase of births and also of marriages will be similar to the increase of population. Although the marriage curve shews a falling off in marriages after 1891 (see page 212), it shews a recovery in 1894, and, with the exception of a small fall for 1903, it continually advanced until 1915. In 1916, 1917, and 1918 a heavy falling off was recorded, unquestionably owing to the European War. The same characteristic is not seen in the curve of births, which, from 1904 onwards, rose continually to 1914, when there was a decline to 1918.

ACTUAL BIRTHS, DEATHS, AND MARRIAGES

Experienced in the Commonwealth during the Years 1890 to 1918, Compared with the Number that would have Occurred if the Rates of 1890 had Remained in Operation.

Year.	BIRTHS.		DEATHS.		MARRIAGES.	
	Actual.	Number of Births that would have been experienced if the 1890 birth rate had been in operation.	Actual.	Number of Deaths that would have been experienced if the 1890 death rate had been in operation.	Actual.	Number of Marriages that would have been experienced if the 1890 marriage rate had been in operation.
1890 ..	108,683		44,449		23,725	
1891 ..	110,187	111,802	47,430	45,737	23,862	24,419
1892 ..	110,158	114,502	42,2 8	46,842	22,049	25,009
1893 ..	109,322	116,617	45,801	47,707	20,631	25,470
1894 ..	104,660	118,734	42,958	48,573	20,625	25,933
1895 ..	105,084	111,002	43,080	49,501	21,564	26,428
1896 ..	100,134	123,212	45,202	50,405	23,068	26,911
1897 ..	101,137	125,419	43,447	51,308	23,993	27,393