HOW FAR CAN THE GENERAL DEATH-RATE FOR ALL AGES BE RELIED UPON AS A COMPARATIVE INDEX OF THE HEALTH OR SANITARY CONDITION OF ANY COMMUNITY?

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Indices to the state of health or sanitary condition of a community are of the utmost importance to all, and especially so to those who are responsible for local sanitary provisions; and hence it is often asked, how far is the general death-rate of any year to be relied upon as a test of either the health or sanitary condition of any place or country?

I shall this evening try to demonstrate that the general death-rate of any one place, though in itself due to a combination of many complex causes, may, nevertheless, be used as a fairly reliable local index to health and sanitary condition, although a most faulty index as regards the comparative health or the sanitary condition of different localities. The dominant influences which determine the total death-rate are these:—

1. The proportions living at various age groups, especially the old age group, 60 years and over.
2. Migration, as affecting the said proportions.
3. Birth-rate as affecting the death-rate of 0-5 years age group.
4. Climate.
5. Seasonal influence.
6. Cosmical or obscure influences varying or intensifying local causes of disease over wide cycles of years.
7. War, violence, and famine.
8. Density of population as exemplified by town and country dwellings.
9. Sanitary provisions.
10. Local conditions of soil, altitude, etc.

Now, of these important influences, which together combine to make up the total death-rate, the first three, though strongly affecting it, are not in the slightest degree connected with either health or sanitary conditions. It is also obvious, so far as any one locality is concerned, that many of the conditions enumerated are more or less constant; while, as regards different localities, and especially countries widely apart, nearly all the conditions come into play as disturbers, and hence it is, that the general death-rate of any one locality

may be a fairly reliable comparative index of the health and sanitary condition from year to year; while, as regards longer periods, or widely separated localities, comparisons by the indication of a general death-rate are often utterly fallacious or misleading.

Much prejudice exists in some minds against the use of figures. " Figures can prove anything," is a current popular phrase.

But even words and phrases, as such, are more easily twisted to wrong uses than figures. Yet we do not despair of arriving at correct conclusions by the aid of facts and figures, where due care, thorough investigation, and logical methods are employed. As a rule it is not so much that the results of computed figures are false, as that careless and false interpretations are put upon them. Lord Derby, while presiding over the statistical section in 1865, happily illustrated some of the mistakes of this kind, by the state-ment that erroneous interpretations are taken from death-rate totals where abnormal causes are not taken into account; for example, " a year of pestilence, not only by its effect on the mortality of the year of its occurrence, but by its clearing away feeble lives, and so lightening the death-rate in years immediately consequent." But, as observed by the President of Section F of the British Association at Birmingham, in 1886, " There is less to be feared from errors arising out of this source, if we lay to heart the warning uttered by Mr. Goschen on a recent occasion. 'Beware of totals';—and if we recognise more fully than we are usually apt to do that a table of figures, even if it be absolutely correct as a statement of facts, is merely raw material, not a finished product. The misfortune is that it is only too frequently treated as the latter."

Now tables of totals indicating the death-rates per year of different countries are too commonly treated as finished pro-ducts, whereas I shall in the following remarks endeavour to demonstrate that they are raw materials, so far as deductions relating to comparative health and sanitary condition are concerned.

With this object in view I shall address myself to illustrate the disturbing effect of the dominant influences already indicated upon the total death-rates in different years and in different places.

THE DISTURBING EFFECT OF VARYING PROPORTIONS OF PERSONS LIVING AT VARIOUS AGE GROUPS.

To fully comprehend the effect of disturbance from this source we must know in a general way the widely differing proportions which each age group of living persons yield to

the yearly death-rate. This is best appreciated by dividing
the ages into three well-marked groups; the first, 0-5 years,
showing the heavy losses at the beginning of life; the
second, 5-60 years, or vigorous period, showing the sudden
descent to a minimum, covering the period of youth and middle
age; the third, 60 years and over, or old age period, suddenly
curving upwards and marking the maximum of loss occasioned
by the natural decay and termination of the more vigorous
lives.

The tables and diagrams give a vivid picture of
the broad proportional agreement that exists in different
countries as regards the losses of life at the three great age
groups. For, notwithstanding the fluctuations caused in
different countries, whether due to climate or peculiarities of
local condition, there is a wonderful similarity in the propor-
tions which different countries yield at each respective age
group.

The *first* ranges between 27·65 and 50·60 per 1,000 living.
The *second* ,,   ,,   5·60 ,, 12·66   ,,   ,,   ,,
The *third* ,,   ,,   49·18 ,, 70·39   ,,   ,,   ,,
The mean of each age group shows the relative proportion
still more clearly thus :—

0-5 years' age group yields 42·15 deaths per 1,000 living.
5 under 60 years   ,,   ,,   7·73   ,,   ,,   ,,   ,,
60 years and over ,,   ,,   61·53   ,,   ,,   ,,   ,,
Thus it appears that there is a very wide difference in the
proportion of deaths yielded by each age group, and hence it
is that if there be any wide difference in the proportions of
the respective groups living in different places, as in young
Colonies, the total death-rate would be so much disturbed
thereby, that comparisons, so far as they refer to health or
sanitary condition, would be erroneous and misleading.
That this is to be expected is made still more apparent by
contrasting the percentages of ages living with the percen-
tages of deaths per year under corresponding age groups.

AGE GROUPS.

Age Group.	Persons Living. Percentage.		Deaths Per Year.			
			Rate per 1,000 Persons Living within same Age Limit.		Percentage to Total.	
	Variation.	Mean	Variation.	Mean	Variation.	Mean
1. 0-5 years	13·5 to 17·01	14·63	27·65 to 50·60	42·15	34·92 to 45·65	39·69
2. 5-60 years	77·93 to 83·18	80·62	5·60 to 12·66	7·33	28·34 to 53·79	39·80
3. 60 years and over ..	1·87 to 8·04	4·75	49·18 to 70·39	61·53	6·38 to 36·74	20·51

A study of the foregoing table reveals that if 1 and 3
group, together representing 19·38 per cent. of the living
population, yield as much as 60·20 percentage of the whole

deaths for one year, it follows, if there be any material difference in the respective living groups of different countries, that the total death-rate would show a corresponding difference, even though the proportion of deaths yielded at each age group were identical in the several countries compared. Thus, though the death-rate of each specific age group were identical in two countries, still the country having the smaller percentage of old age and children living would show a *lower death-rate.* Nay, more. If the variation be considerable, the country with the *smaller* percentage of extremes of youth and old age living would show a *lower total death-rate,* even where the ratio of deaths at specific ages was much *higher.* Take, for example, two towns of 100,000 inhabitants, as in the following illustration :—

Illustration of two towns, each with 100,000 inhabitants, but differently proportioned as regards age groups living, although the proportion of deaths yielded by both are the same in relation to each age group.

	Pop.	Percentage living at			No. Deaths per Year				Deaths per 1,000 Persons at each Age given.				
	No.	0-5	5-60	60 and over.	0-5	5-60	60 and over.	Total.	0-5	5-60	60 and over	Total.	
Town A	100,000	13·50	84·63	1·87	613	474	92	1179	38·00	5·60	49·18	11·79	Dif. of 2·82 per 1,000
Town B	100,000	17·01	74·95	8·04	646	420	395	1461	38·00	5·60	49·18	14·61	

This is a good illustration of cases where the total death-rate is a faulty comparative index to the state of health or sanitary condition, for the difference 2·82 per 1,000 is due entirely to the varying proportion of persons living at each age group, and not to any difference in the proportion of deaths yielded by them.

Illustration of two towns each with 100,000 inhabitants, but differing in proportion as regards age groups living, and also differing in the proportions of deaths yielded by each group.

		Pop.	Pop. Percent. Living at each Age Group.			No. of Deaths per Year.				Deaths per 1,000 Lives at each Age Group.			
		No.	0-5	5-60	60 and over.	0-5	5-60	60 and over.	Total.	0-5	5-60	60 and over.	Total.
Town C	..	100,000	13·50	84·63	1·87	569	654	115	1338	42·15	7·73	61·53	13·38
Town D	..	100,000	17·01	74·95	8·04	646	420	395	1461	38·00	5·60	49·18	14·61
Town E	..	100,000	17·01	74·95	8·04	717	579	494	1790	42·15	7·73	61·53	17·90

This comparison again still more forcibly illustrates the faulty indication of the total death-rate, as regards the comparative state of the health or sanitary condition of the two towns taken; for it so happens that D, which has a much smaller yield of deaths relative to each age group, is nevertheless made to appear 1·23 per 1,000 person *higher* than C by the total death-rate; whereas the true relation of C, in relation to health and sanitary condition, as compared with D, can only be ascertained by computing C's death-rates at each age group in connection with the same living age group proportions, as in D.   By this means alone would a true comparison be effected between them as regards health and sanitary condition, and instead of C being 13·38 per 1,000 persons, and lower than D by 1·23 per 1,000, it is, as regards health in relation to D, really equivalent to 17·90 per 1,000 persons living, or equal to 3·29 per cent. per 1,000 *above the index of D.*

Since the *Health Standard* was proposed by me in 1882, another method for effecting truer comparisons than offered by the total deaths between different countries has been adopted by Mr. Hayter (Year Book for 1885, pp. 264-268), termed by him the *Absolute Death-rate.* This consists of ignoring actual proportions living at each age altogether, and artificially substituting uniformity of proportion, by recognising fifteen age groups of equal value (say 1,000 for each).   It makes no allowance for the element of old age, and consequently this health element neutralises the true approximate indication of proportion from preventible causes.   It is, however, an admirable method in many respects, although its general results would still produce anomalies in comparisons relating to health and sanitary condition.

The method would be greatly improved if the fixed standard for the various age groups were more closely approximated to the actual proportions living in different countries.   By dividing them into three groups, as follows, this might be effected very closely, viz.:—

Let A = Represent proportion of ages living   0-5 years = 3 *
      B =   ,,   ,,   ,,   ,,   5-60   ,,   = 16*
      C =   ,,   ,,   ,,   ,,   60 and over = 1 *
      R a = Death-Rate actually yielded by ages living 0-5
      R b =   ,,   ,,   ,,   ,,   5-60   ,,
      R c =   ,,   ,,   ,,   ,,   60 & over
      D. = Relative Death-Rate for all ages.

<div align="center">Then,</div>

$$\frac{AR^a + BR^b + CR^c}{A + B + C} = D$$

* These figures are the lowest simple relative approximates to the mean proportions living within the respective age groups.

A *Relative Health Standard* might be fixed similarly for comparison between different countries, by combining age groups under 60 by the same fixed values and by eliminating $\dfrac{CR^c}{C}$ Thus :—$\dfrac{AR^a + BR^6}{A + B}$ =H·or *Relative Health Standard.*

If the death-rates for Australasia be compared by these methods, the following would be the results for each Colony :—

DEATH-RATE PER 1,000 PERSONS LIVING.

		ALL AGES.			"HEALTH STANDARD" (AGES UNDER 60.)	
		Absolute.	Actual.	Relative.	Actual.	Relative.
New Zealand	... 1885	16·20	10·76	11·54	9·51	9·59
Tasmania	... 1885	20·74	15·40	13·75	10·59	10·77
South Australia	1885	17·67	12·48	12·91	10·74	10·81
Victoria ...	... 1885	21·48	14·73	15·49	12·23	12·84
New South Wales	1884	19 99	15·88	15·55	13·23	13·32
Queensland	... 1885	26·04	19 58	21·09	18·48	18·68

As regards the value of these five standards as comparative indices of health and sanitary condition, there can be no doubt of the superiority of the *Actual* and *Relative Health Standards*, and the following may be taken as the order of their respective values as health indices :—

1. Actual Health Standard (ages under 60).
2. Relative   Ditto   Ditto.
3. Relative Death-Rate for all ages.
4. Absolute   Ditto   Ditto (Hayter's method).
5. General Total Death-Rate for all ages.

Thus there are five methods for effecting comparison.

1. The Total Death-Rate for all ages, which makes no allowance whatever for the varying proportions of age groups.
2. Hayter's Absolute Death-Rate for all ages, giving an arbitrary fixed value of 1,11 and 3 to ages living 0-5, 5-60, 60 and over, respectively ; superior to total death-rate, but defective inasmuch as the arbitrary fixed values do not approximate to the average mean of the actual proportions of the several age groups, and because it ignores the disturbing element of old age in comparisons regarding health and sanitary condition.
3. "The Relative Death-Rate " for all ages, giving a fixed value of 3,16 and 1, for ages 0-5, 5-6, 60 and over, respectively, based upon the actual average proportions of the several age groups living, but defective as a standard of health, by including the old age element.
4. " The *Relative Health Standard* " for ages under 60, giving a fixed relative value of 3,16 to the two groups 0 5 and 5-60, and so approximating to actual living proportions. This method eliminates the old age element,

and is convenient for effecting comparisons with countries where the rates yielded for the particular groups are already computed.

5. "The *Actual Health Standard*" for ages under 60, giving the true yield of deaths per 1,000 persons actually living under the same age limit in each country, and thus effecting the best form of index as regards the comparative health and sanitary condition of different countries, by the elimination of the healthy old age element.

Of course these and other standards are supplementary to the more minute analysis, showing the actual death-rate at each specific age group.

That there is a great disparity in the proportion of living persons at each age group in the Australasian Colonies has already been shown, but it is nowhere so strikingly apparent as in the Colonies of Tasmania, Queensland, and New Zealand.

This is at once apparent by observing the proportions in each Colony of persons living, and of deaths occurring in the old age group.

PERCENTAGES OF DEATHS 60 YEARS AND OVER.

		Persons living 60 years and over.			DEATHS, 60 yrs. & over.		
1. Tasmania	.. 8·04	percent. (1881 census.)			36·74 percent. (1885)		
2. Victoria	... 4·65	,,		,,	20.75	,,	,,
3. South Australia ...	4·13	,,		,,	.17·48	,,	,,
4. N. S. Wales	... 4·31	,,		,,	16.34	,,	,,
5. New Zealand	... 2·72	,,		,,	14·67	,,	,,
6. Queensland	... 1·87	,,		,,	6·38	,,	,,

Here we are at once struck with the fact that, included within the total death-rate in Tasmania (15·40 *per* 1,000 persons), there is 36·14 per cent. of the total deaths for ages 60 years and over. While in the total death-rate of Queensland (18·47 per 1,000 persons) there is only included 6·38 per cent. of the total deaths for ages 60 years and over. That this is solely due to the greater number of persons in Tasmania living at this age group (8·04 per cent), and not because of lack of health, is made unmistakably evident by computing the mean of all ages at death in the 60 years and over age group. This would show :—

			Percentage of death 60 and over.		Mean age at death.	
Tasmania	...	...	36·74	...	77·71	years.
Queensland	...	...	6·38	...	70·31	,,
Victoria	...	...	20·75	...	71·54	,,
South Australia		...	17·48	...	72·69	,,
New South Wales		...	16·34	...	72·63	,,
New Zealand ...		...	14·67	...	71·36	,,

This again proves that the true test of the death and sanitary condition for the *old age group* is longevity rather than the *accidental proportion* to the comparatively small number living at this age ; and according to this test Tasmania, with a mean age of 77·71 years for all deaths at age group 60 years and over, is far above any other country.

Where, as in Tasmania, the mean age of 36·74 per cent. of the deaths exceeds the allotted span of life, "threescore years and ten," and where old age in itself among specific causes heads the list, it is evident that the total death-rate, which includes and conceals this important element, must in itself be a most unsatisfactory test of health or sanitary condition between different countries or places, although fairly good enough where comparisons are made for different years in relation to the same locality.

Extreme old age, *per se*, is an infallible index of health, whether due to the life or its environment.   Therefore, to mingle deaths from extreme old age with deaths from the more or less preventible causes in any common rate used as a test of sanitary condition, must, as I have shown, frequently result in anomalies and confusion.

Under any circumstances, as already urged by me in my report on Vital Statistics for 1882, it would seem to be most desirable to separate the deaths from extreme old age from other causes in analysis of matters bearing upon health or sanitary condition ; for although in imagination we could, with Dr. Richardson, conceive of the future *Hygeia* as perfectly freed from preventible causes of death, yet if it be admitted that the fully ripe aged must die sooner or later, we must also conceive that, as we approach the ideal City of Health, the proportions of death in childhood, youth, and middle age can only diminish as the proportion of old age increases.   Thus, when the future Registrar-General can record deaths from extreme old age " 100 per cent.," there will be perfect health and peace, and the only value of the annual death-rate for all ages will be merely as a measure of the natural increase or decrease of population.   From these considerations it is clear that the ordinary death-rate index for Tasmania is not a fair test of her sanitary condition as compared with the neighbouring Colonies, for of all countries with whose statistics I am acquainted there is none which so closely approaches the ideal standard of perfect health.

It may be that one is generally more satisfied with a bantling of one's own creation ; but, making allowance for this, I am also strongly convinced, that the *Health Standard* proposed by me in 1882 (viz., deaths under 60 years compared with the population living under the same age limit) would more fitly than any other method fulfil all the condi-

tions required in a general death-rate for testing the health
and sanitary condition of different places.

By this standard two very desirable objects are secured.
First, the widely disturbing effect of differing proportions
of the old age group is entirely eliminated and truer com-
parison as regards comparative health may be attained; and
second, the element of *old age*, whose proportions over 60 are
in themselves good indices of environment, are not mixed
up with deaths due to adverse causes, and so producing
confusion in the general result, as in the total death-rate and
other standards for all ages. The national death-rate for all
ages, it is true, is a very simple and ready test, and may
still be used with advantage in some countries where the
age relations are comparatively stable, but in the Colonies,
where these relations are continually disturbed by migration,
the *Health Standard*, as already defined, is more reliable, can
be applied universally, is simple, and, for comparison, easily
computed.

It would also be of the greatest value in the comparison
of different cities in Europe, by minimising the errors of
comparison arising out of migration between town and
country districts.

To Health Officers, who are responsible for the sanitary
conditions of towns, such a test would prove of great
advantage, and it would often save them from unmerited
opprobrium based upon the unreliable total death-rate index,
which takes no account of the important disturbances caused
by the variation of age group proportions.

Mr. N. A. Humphreys, in 1874, read a masterly and useful
paper before the Statistical Society of London, in defence
of the general utility of the total death-rate as an index to
comparative health so far as England is concerned; but
he admitted its defects, and many of his conclusions have
been combated by Mr. Thos. A. Welton, Dr. Letheby, and
other well-known authorities on vital statistics.

As regards the disturbed age groups of the Colonies, how-
ever, Mr. Humphreys would probably admit that the general
death-rate for all ages would be unsatisfactory and mislead-
ing as a comparative index of health.

These conclusions are fully borne out by placing the
results of the two methods side by side as applied to the
Australasian Colonies.

	DEATHS ALL AGES, Per 1,000 persons.	"HEALTH STANDARD." DEATHS UNDER 60 YEARS. Per 1,000 persons under same age.		DEATHS OVER 60 YEARS.	
				Per centage to total Deaths.	Mean Age at Death.
New Zealand, 1885	10·76	...	9·51	..	14·67	71·36
Tasmania, 1885 ...	15·40	..	10·60	..	36·74	77·71
S. Australia, 1885	12·48	..	10·74	...	17·48	72·69
Victoria, 1885	14·73	...	12·23	..	20·75	71·54
N. S. Wales, 1884	15·88	..	13·24	...	16·34	72·63
Queensland, 1885	19·58	..	18·48	..	6·38	70·31

Thus, by the total death-rate, the several Colonies take up the following order, in which Tasmania is made to occupy the fourth position, while, by the more accurate *Health Standard*, Tasmania rightly occupies the second position.

By the *Total Death-Rate* index:—1, New Zealand; 2, South Australia; 3, Victoria; 4, Tasmania; 5, New South Wales; 6, Queensland.

By the *Health Standard*:—1, New Zealand; 2, Tasmania; 3, South Australia; 4, Victoria; 5, New South Wales; 6, Queensland.

The order of greatest percentage living over 60 is also shown thus:—1, Tasmania; 2, Victoria; 3, South Australia; 4, New South Wales; 5, New Zealand; 6, Queensland.

The true test of comparative health for this group is longevity, and in this respect Tasmania again heads the list:—1, Tasmania; 2, South Australia; 3, New South Wales; 4, Victoria; 5, New Zealand; 6, Queensland.

The misleading nature of the total death-rate as a test of comparative health and sanitary condition is still more forcibly illustrated in regard to comparisons made between cities where the age groups are differently constituted. Thus the total death-rates for the following cities are placed in the order of the highest death-rate for all ages.

		DEATH RATE per 1,000 persons.
1. Hobart,	1885	24·70
2. Sydney,	1884	23·33
3. Brisbane,	1885	21·64
4. London,	1885	19·7
5. Adelaide,	1885	18·9

But, when we come to analyse the figures, it is at once made apparent that the order is far from correct, as indicating comparative health or sanitary condition, for the proportion of age group 60 and over is extremely variable, thus:—

	Percentage of Deaths over 60 years.	Mean age at death.
Hobart, 1885	43·46	74·30
Adelaide, 1885	18·80	71·91
London, 1885	12·89	73·37
Sydney, 1884	11·96	71·22
Brisbane, 1885	8.54	71·08

From this it is clear that the Hobart total death-rate of 24·70 per 100, which includes 43·46 per cent. of ages 60 and over, cannot fairly be contrasted by this means (from a health point of view) with the other cities, which only contain from 8·54 to 18·80 per cent. of the old age group, especially so when we consider that in Hobart the mean age at death of the group is the highest.

The truer index of the relative health and sanitary condition, as computed by the *Health Standard,* would place Hobart far before the others. It is not always possible, however, to make a close estimate of the ages living under 60 in cities, but if we measure deaths under 60 by the estimated total population, we get a close approximation to relative value of the condition affecting health and sanitation in the cities compared, thus :—

Deaths under 60 years per 1,000 persons living·

1. Hobart,	1885	13·97
2. Adelaide,	1885	15·42
3. London,	1885	17·16
4. Sydney,	1884	19·52
5. Brisbane,	1885	19·79

Thus it is evident that the true index to health and sanitary condition of different places can only be obtained by eliminating the old age group, as in the method of the *Health Standard.* Comparisons by the usual mode are widely misleading. The very remarkable circumstance that Hobart shows 43·46 per cent. of the total deaths, as being 60 years and over, with a mean age at death of 74·30 years, is of itself sufficient as to prove the reasonableness of these conclusions.

The Influence of Migration

The death-rate for all ages is also greatly affected by Migration, as it invariably disturbs the proportion of the principal age groups.

The bulk of Immigrants to cities and young Colonies consists of persons between the ages of 5 and 50. This is the period of life, as already explained, when deaths are at a minimum, relative to the same age group living. In most of the Australasian Colonies the death-rate for this group ranges between 5·60 and 7·72 persons per 1,000 living.

Where Immigration is large in proportion to the original population, there will certainly be a very great fall in the total death-rate, without any change in the proportional yields for each age group, and without any material change in the conditions affecting health.

Thus if a stream of Immigration equal to 10,000 per year of ages between 5 and 50 were absorbed by a young Colony whose original normal population was 200,000, with a total death-rate of 15·40 per 1,000 ; then if the death-rate for ages 5-60 was only 6·17 per 1,000, it follows that in ten years the total death-rate would be reduced to 12·32 per 1,000—that is a fall of 3·08 per 1,000 in the total death-rate without any alteration whatever as regards death-rate yield for particular ages, and with no material

alteration in the conditions affecting the health or sanitary state of the Colony.

A corresponding increase in the total death-rate, however, need not be expected in the country from whence Immigration proceeded, as the numbers in most cases would be comparatively insignificant.

Thus if the country from whence Immigration proceeded originally numbered 36,000,000, with a normal death-rate for all ages of 20 per 1,000—then a stream of Immigration, equal to 10,000 per year for ten years, of persons between 5 and 50 years of age would only have the effect of increasing the total death-rate for all ages, by about 0.004 per 1,000.

From such considerations therefore, it is evident that a very considerable decline in the death-rate of a young Colony, which yearly absorbs a large number of Immigrants, may be almost entirely ascribed to this cause, and not to any improvement in local health or sanitation.

From similar considerations it is also evident that the comparatively low death-rates of some large cities may be due in great measure to the absorption of fresh country lives between 15 and 40 years, and not to the comparative health and sanitation of the city. The comparative high death-rate of young lives in rapidly growing cities confirms this view of the case. These considerations should be borne in mind in comparing the total death-rates of different places; and here again it may be safely affirmed that the *Health Standard* would prove to be more reliable than the total death-rate as a test of comparative health and sanitary condition.

The Influence of the Birth-Rate.

The next most important influence acting as a disturber of the comparative value of the death-rate for all ages is the birth-rate.

To appreciate the effect of the birth-rate disturbance it is necessary to bear in mind that the deaths under 1 year of age range from about 96 to 220 per 1,000 births per year, and comprise from about 22 to 25 per cent. of the total deaths. It follows, therefore, if the birth-rate be abnormally high in any year, that the total death-rate would be considerably increased without any disturbance of the local condition affecting health.

It has long been observed that an improvement in material welfare leads to a corresponding increase in the marriage and birth rates; and hence it follows that any unusual improvement in the material welfare of a country has an intimate relation with causes which tend to increase the proportion of deaths under one year of age, and thus considerably increase

the total death-rate for all ages without any disturbance of matters affecting the local health and sanitary conditions.

The foregoing influences may be described as the principal disturbers of the death-rate index, although in no way affecting the conditions connected with health and sanitation.

The influences commented upon hereafter (viz., season, climate, cosmical or epidemic visitations, war, famine and violence, density of population, etc.,) form a group which greatly affects both health and death rates for all ages, even though the state of sanitation be good, or at any rate normal, and therefore comparatively neutral as regards death-rate variations.

The Influence of Climate.

Independently of all other causes enumerated, the death-rates of different countries are seriously affected by special diseases, which are more or less restricted to given geographical limits. Yellow Fever may be taken as an example of diseases of this kind, being mainly restricted to certain tropical latitudes, and there, again, mostly confined to low-lying plains adjacent to the sea.*

The total death-rate for such places certainly may give a fair index of its health from year to year; but its presence or absence in different countries is a condition of latitude rather than local hygiene.

* Hirsch states that in the Western Hemisphere its range extends between 32°·46 N., and 22°·54 S., and in the Eastern Hemisphere between 14°·53 N., and 5°·7 N.

The Influence of Season.

The seasonal influence has an important bearing upon health, although its influence is similar in different years. Its effect, therefore, is seen in the varying monthly or quarterly death-rates rather than in the total yearly death-rate.

If we take our own local experience of the influence of each month, and reduce it to a diagraphic form, we readily perceive that there is an intimate relation between the temperature and the death-rate.

These temperature extremes are in January and July, the first showing the maximum, the second the minimum. Now, extremes of heat and cold are both injurious to health, although, upon the whole, the former is more fatal. The death-rate curve for the year sensitively follows the double curves of temperature, although the second curve occurring between April and November appears in inverse order. Thus the double death-rate curves and double temperature curves run together (between November and May, and May and November), the maxima of the two death-rate curves closely

corresponding respectively with the maximum and minimum
curves of temperature, thus:—

	Temperature.*		DEATH-RATE.† per centage.	
November	57°·8		7·03	
December	60 ·1 ⎱		8·97 ⎱	Major
January	63 ·3 ⎬ Max.		9·48 ⎱	max.
February	60 ·8 ⎰		8·64 ⎰	
March	59 ·3		8·28	
April	55 ·9		7·93	
May	50 ·5		8·39	
June	46 ·9 ⎱		7·67 ⎱	Minor
July	45 ·7 ⎬ Min.		8·90 ⎬	max.
August	48 ·7 ⎰		8·62 ⎰	
September	52 ·1		8·18	
October	53 ·6		7·91	
Mean	54 ·4		8·33	

These curves are best appreciated when shown in diagraphic
form, and comparisons in this way show the close corre-
spondence which exists between deaths from zymotic diseases,
deaths of children, the major maximum total death-rate
curve, and the maximum curve of temperature.

At the same time there may be seen also a close corre-
spondence between the curves of deaths relating to old age,
deaths from diseases of the respiratory system, the minor
maximum seasonal death-rate curve, and the minimum curve
of temperature.

It is clear, therefore, that the death-rate variation of
particular months is of no value in itself as an index of local
sanitary condition, which seldom varies to any extent within
the space of one year; and therefore this form of death-rate
variation must, in nearly all cases, be ascribed principally to
seasonal influences lying beyond human control. The Typhoid
seasonal curve is a very remarkable one.   It is at its lowest
point invariably from July to November inclusive, rising
rapidly to its highest point in March, and from that point
falling as rapidly to the beginning of its minimum period in
July.

This curve is not in any way disturbed by the rise and fall
of its death-rate in different years.   A glance at the diagram
showing the deaths from Typhoid in Australasia shows clearly
a periodic rise and fall during the last twenty years, with an
average duration of fully four years for each period.

The close agreement between the various widely separated
Colonies in these periodic curves teaches us caution in referring
the unusual rise or fall to causes altogether local.

Local causes, no doubt, are fairly indicated by the smaller or
greater intensity of the rise or fall, but the actual tendency

in itself to rise or fall during each period is more probably referable to some hidden cosmical influence.

Thus there are probably three great causes operating, as regard the variations of Typhoid, viz:—1. Local hygiene; 2. Seasonal influence; 3. Cosmical influence. None of which may be neglected in forming a correct opinion from local death-rate data.

THE INFLUENCE OF COSMICAL OR OBSCURE CAUSES, SUCH AS EPIDEMICS, IN ADDING TO OR VARYING THE INTENSITY OF LOCAL CAUSES OF DISEASE OVER WIDE CYCLES OF YEARS.

If we study the diagram showing the movement of the death-rate in Australia and Europe since 1850, we at once perceive a series of waves generally covering a period of ten to eleven years. These are somewhat modified in different countries by what we may term subordinate ripples upon the greater wave, but these in no way disturb the close agreement of the greater waves, or cycles. The length and the time occupied by each great cycle closely correspond with the sun-spot periodicity.

There can be no doubt of the marked agreement of the disturbance of the general death-rate of the various Colonies in Australasia, each of which differs in the actual death-rate relative to their respective populations. It becomes a most important question, then, to enquire whether and how far these wave-like disturbances—not the relative local death-rate peculiar to each place—are within the limits of human control, and, therefore, to what extent are they of value as an indication of local sanitary conditions?

The cause of this periodic rise and fall in the death-rate occurring simultaneously in different widely separated countries is, I admit, a most difficult question. It is open to us to consider the results as due

1. To human neglect of, or attention to, sanitary conditions fluctuating simultaneously in different countries, in accordance with the periodic fluctuations of the death-rate.

2. To periodic fluctuations in the intensity of specific zymotic diseases in centres where they are endemic—but periodically becoming epidemic or pandemic when the period of intensity is at its height.

3. To periodic fluctuation in the medium or channels of conductibility from endemic centres, the death-rate decreasing with the increase in non-conductibility and increasing with its increased powers of conductibility.

4. To hidden cosmical influences simultaneously affecting the life and activity of disease germs throughout wide

regions of the earth's surface, and fluctuating in a wave-like rise and fall of longer or shorter cycles, as in the well-known fluctuations of magnetic variations and sun-spot intensities; favourable or unfavourable conditions in different regions,intensifying or diminishing the general effect, but not altogether dissipating its influences.

As regards the first of these (human action or inaction) it needs only to be mentioned to be at once rejected; for whatever value we may ascribe to the ameliorating influence of human action in improving sanitary and other conditions connected with health and the treatment of injury or disease, and thus lessening the severity of attacks of disease, whether epidemic or endemic. Still we can hardly conceive that men's minds and action should act in concert, consciously or otherwise, in all local centres over many countries so as to produce a rhythmic result upon local health, corresponding to the rhythmic rise and fall observable in the actual death-rate of countries widely separated during many years.

It must be borne in mind that knowledge tends always to increase, and improvement must needs follow in one direction, however slow it may be. Action, though fitful, always follows upon increasing knowledge; and although it may be more than counterbalanced by the tendency of people to become unduly aggregated in old or new centres, still the failure to advance with increasing needs would not result in such rhythmic rise and fall in relation to the generally improving provisions, so as to agree with the death-rate cycles referred to.

Again, the habit of referring any unusual epidemic visitation to a chance medium for its communication from a distant endemic centre, either by infection or contagion, is a most unsatisfactory explanation.

This only places us a link further back in a possible chain of causation. Is it true that the channels of communication from endemic centres are only open to infection or contagion at periods corresponding to local death-rate cycles? Even if we admitted this in some cases, it would still leave us without an answer in respect of the fluctuations of intensity over well-marked cycles, in the very centres where a specific disease is endemic and never wholly absent.

The only natural explanation of these extraordinary fluctuations, as regards origin, is to refer them to unknown or obscure cosmical influences, the sum of which may harmonise with the known periodicity of the death-rate occurring simultaneously in countries wide apart. This reference is justified by analogy, with known modes of cosmical or superterrestrial disturbance. For example, we

know the seasonal variation of temperature corresponds with the seasonal death-rate variation, and, whether it be a direct or indirect relation, we must admit that the varying intensity of the sun's energy from season to season, has much to do with the varying effects upon human life.

If, therefore, the small variation of the sun's position, and consequent energy relative to a given portion of the earth's surface, produces such noticeable effects within each year upon temperature, and through it the death-rate, is it not very reasonable to suppose that variations in the sun's energy, independent of the earth's distance from it, should produce corresponding disturbances in harmony with the larger cycles covering periods of several years ? It is not necessary to indicate the special form of direct energy exerted by the sun over terrestrial matter, whether of light, heat, or magnetism. It is enough for my argument to claim that all of these, directly or indirectly, exert a most powerful influence upon terrestrial life and motion. Now, it has been clearly proved that the sun's energy is subject to cycles of disturbance, in the shape of violent photospheric storms, producing a perceptible diminution of light emitted, if not of heat ; and what is more important, for the purpose of my argument, these periodic sun storms—termed sun-spots— have been proved, by careful observation, to produce upon the earth a marked corresponding wave of variation in the magnetic curve.

If this be so, and I see no good reason for doubting the alleged facts, does it not follow that the variation of the sun's energy in light and magnetism must produce effects upon terrestrial life corresponding in time with its periodicity, and in effect, though differing in degree, corresponding with the shorter cycles of seasons recurring year by year ?

This may be termed a craze, like all other suggestions of a far-reaching and novel character, but I am quite willing to run the risk of being accused as crazy on this subject if fact and reason give it support. That it has much support, though falling short of perfect demonstration, is very suggestively borne out by the close correspondence that exists between the periodicity of the sun spots and that of the Austra- lasian death-rate during the last twenty years. The general agreement in Australia between each distant Colony, as illustrated in diagram, is all in its favour. And, as already suggested, it may be that in the young Colonies where the mean death-rate is lower than that of Europe by 10 per 1,000 persons living, and where local artificial causes of death are at a minimum, the death-rate more sensitively indicates the effects of obscure superterrestrial influences than in crowded

centres of population, as in Europe and other Old World centres.

In any case, whatever difficulty remains unexplained as regards the periodicity of the death-rate, the reference to a cosmical or superterrestrial influence has more to commend it than the other three sources so frequently referred to without support of a satisfactory character.

Let me not be understood, however, to assert the valueless-ness of human effort by ascribing the periodical death-rate, rise, and fall, mainly to far reaching superterrestrial causes, among which the sun's varying energy plays a large part. On the contrary, I desire to affirm that human effort, directed to selection of sites for dwellings; supplies of pure food and water ; to provision against poisonous food and drinks ; to improvements in sanitary matters, and to facili-ties for healthful recreation; to improvements in workshops and factories ; to the multiplication of acknowledged health safe-guards and of convenient centres for the proper treatment of disease, as well as to improvement in treatment of injuries and diseases. In all such matter human effort does much, and can do more, to mitigate the intensities of attacks of disease, from whatever source they come, even if it cannot wholly subdue them. That sanitation and improved treatment have done much in England during the last twenty years to lower the death-rate of the younger lives cannot be reasonably doubted, and this of itself should encourage local effort to strive for further improvememt.

Man's Influence. Density of Population and Hygiene.

Except as an ideal standard of health, there is not much value in making comparisons between urban and country districts, because density of population is itself an important factor in raising the death-rate. If we examine the mean death-rate of urban and country districts during the years 1882-5, we find, after making due allowance for old age, hospitals, and public institutions, that the former indicated for ages under 60, 13·83 per 1,000, and the latter 8·13 per 1,000 ; that is a difference of 70·1 per cent. This is an enormous difference in favour of country districts. It is true that the centralisation in the urban districts of the sick in Hospitals, and of paupers and criminals from all parts of the country, artificially increases the death-rate of the former, and lessens that of the latter, to a much greater extent than happens in countries where Hospitals and Asylums are more generally distributed.   Notwithstanding this, however, and while recognising on the average that the occupations of townspeople are more unhealthy than those of

people living in country districts, and making due allowance
for the important excess of the age element in urban dis-
tricts, there is still a very great difference, which is difficult
to account for satisfactorily in a young country ; and while I
am of opinion that the lower death-rate in country districts
is not due to the relative superiority in artificial modes of
sanitation as compared with urban districts, it is becoming
evident that the closer contiguity of dwellings in towns
demands that artificial sanitary measures in the latter should
be specially framed to provide for those unfavourable condi-
tions peculiar to all crowded centres of population. In
villages and townships the several dwellings, even although
more imperfectly conditioned in themselves as regards local
sanitary provision, are naturally more perfectly insulated
from each other by more or less broad regions of pure air.
The poisoned exhalations of every individual dwelling do not
spread and become more virulent by coming into direct
contact with the poisoned atmosphere of neighbouring
dwellings, but are at once dissipated or purified by that
septum of pure air which it is reasonable to infer insulates
dwelling from dwelling in thinly populated country districts.
In urban districts, on the contrary, the septum of pure air
surrounding each dwelling does not exist, or only exists
temporarily or imperfectly, and consequently, notwithstanding
special medical supervision, purer water supply, and in many
cases superior sanitary provisions, the death-rate is invariably
higher, and the atmosphere of every well regulated dwelling,
is more or less in direct contact with the exhalations of every
noxious centre within the town. Hence it would appear that
the absence of the insulating septum of pure air around
town dwellings renders the inmates of every house more
liable to the attack of all infectious diseases which may be
floating in any part of the atmosphere within the town.
Even the otherwise healthy wind may be the agent which
directs the fatal effluvia from an unhealthy centre upon a
relatively pure and healthy division of the town.

A town dwelling, therefore, unlike country dwellings, is
insecure as regards health so long as any centre or dwelling
within its boundaries is allowed to vitiate the common
undivided atmosphere with poisonous exhalations. A special
responsibility therefore rests upon Town Boards of Health
to prevent, as far as possible, the creation and spreading of
all noxious exhalations anywhere within their province.
Improved antiseptic measures should be devised and rigor-
ously enforced in every part of the community.

There can be no doubt that urban and country district
death-rates prove that the crowding together of human
beings in particular centres is injurious to the health, and

although the social needs of modern civilization render it impossible to prevent such aggregation, wise provision may mitigate its attendant evils by reducing this tendency to a minimum. This may be more easily effected in new countries, by only allowing town allotments to be proclaimed after the careful selection of healthful sites situated in localities where a good water supply and healthful drainage can be secured. Good ventilation, at the same time, can only be secured by a proper system of streets and lanes, and central reserves for parks. By prescribing the breadth of great intersecting broadways for each division; the minimum width of streets and lanes; the minimum area of central parks within each division; and the minimum air space in dwellings and workshops for each person, the tendency to over-crowding would be minimised, and a healthful circulation in all quarters secured.

No building should be allowed to be erected until plans of the same, completed according to prescribed forms of structure, ventilation, and drainage, were passed and approved by a permanently appointed Board of competent advisers; and the removal of all refuse and filth should be effected entirely by the town authorities, by the best methods suited to the particular locality.

Together with these provisions we must also include the influence of man in the prevention and treatment of injury and disease. The healthful selection of Hospitals, the proper isolation of cases deemed to be contagious or infectious, and the proper treatment of cases, have also a very important influence upon the death-rate of each locality.

CONCLUSION.

In conclusion I think it has been made tolerably clear by these observations, that while the total death-rate for all ages may be used locally as a fairly reliable index of the health and sanitary condition of the same place from year to year, it has been proved to be a most fallacious index as regards the comparative health and sanitary condition of different localities, owing mainly to the extreme variability in the proportions living in different places under the principal age groups. The elimination of old ages, as in the *Health Standard*, has been shown to be a more reliable index between different countries. As regards variations from year to year, it is hoped that the observations made may be helpful to others in making proper deductions therefrom.

DEATHS FROM ALL CAUSES, YEAR 1885.

Colony.	Total Populat'n (mean).	NUMBER.				
		0-5	5-60	60 and over.	Unspe-cified.	All.
Victoria	975,040	5181	6185	2980	19	14,364
New South Wales, 1884... ..	895,533	6228	5550	2324	118	14,220
Queensland	318,415	2419	3354	398	64	6235
South Australia	319,515	1820	1469	697	1	3987
Tasmania	132,166	711	577	748	..	2036
New Zealand	565,012	2345	2839	892	5	6081

		PERCENTAGE.				
Victoria	..	..	..	36·07	43·06	20·75	0·12	100·
New South Wales, 1884	..	...	..	43·80	39·03	16·34	0·83	100·
Queensland ...	..	...	...	38·80	53·79	6·38	1·03	100·
South Australia	...	...	..	45·65	36·85	17·48	0·02	100·
Tasmania... ..	...	...	...	34·92	28·34	36·74	..	100·
New Zealand ...	...	...	..	38·56	46·69	14·67	0·08	100·

DEATH-RATE AT EACH AGE GROUP, AND FOR ALL AGES, YEAR 1885,
Compared with Percentage of Population Living under the same Age Group.

Colony.	Percentage Proportion of Living Persons, Census 1881.				Death-Rate at each Age Group and for All Ages.					Mean Age at Death of Age Group,60 & over.
	0-5	5-60	60 and over.	All Ages.	0-5	5-60	60 and over.	All Ages under 60.	All Ages.	
Victoria	13·22	82·13	4·65	100	40·19	7·72	65·72	12·225	14·73	71·54
New South Wales..	14·84	80·85	4·31	100	45·08	7·37	57·92	13·233	15·88	72·63
Queensland ...	14·95	83·18	1·87	100	50·81	12·66	66·84	18·476	19·58	70·31
South Australia ...	14·89	80·98	4·13	100	38·25	5·67	52·81	10·737	12·48	72·69
Tasmania	14·03	77·93	8·04	100	38·34	5·60	70·39	10·597	15·40	77·71
New Zealand ...	17·01	80·27	2·72	100	27·65	6·17	49·18	9·51	10·76	71·36

DEATHS FROM TYPHOID (1882-1886.)

				TASMANIA.				VICTORIA.	
				Hobart. No.	Launceston. No.	Country Districts. No.	Total. No.	Melbo'rne No.	All Victoria. No.
1882	..	...	..	5	16	15	36	197	472
1883	..	..	...	10	26	28	64	275	661
1884	..	..	...	14	11	5	30	220	456
1885	..	..	..	14	11	5	30	183	424
1886	..	...	...	9	25	13	47	...	..
Total for 5 years			..	52	89	66	207		

DEATHS FROM TYPHOID (1868-86).

	Absolute No.	Deaths per 10,000 of the Population.	
	Tasmania.	Tasmania.	Victoria.
1868	32	3·21	
1869	32	3·16	
1870	26	2·59	
1871	8	0·79	
1872	30	2·93	
1873	24	2·32	3·68
1874	44	4·22	6·05
1875	50	4·81	5·78
1876	26	2·49	4·71
1877	41	3·86	6·58
1878	50	4·61	6·48
1879	38	3·42	5·25
1880	29	2·55	3·49
1881	33	2·81	4·04
1882	36	2·98	5·30
1883	64	5·15	7·21
1884	50	3·89	4·82
1885	30	2·36	4·35
1886	47	3·43	...
Mean		3·24	5·28

*Comparative Table showing the suggested coincidence between the
Death-rate and certain super-terrestrial phenomena.*

ANNUAL DEATH-RATE OF VARIOUS COUNTRIES.

	Europe.		Australasia.							Mean of principal States of Europe.	Mean of the Seven Colonies of Australasia.	Sun-spot Numbers (Wolf's.)	Relative position of Jupiter in his orbit. A. Aphelion. P. Perihelion.
	England.	Sweden.	Victoria.	New South Wales.	South Australia.	Queensland.	Western Australia.	New Zealand.	Tasmania.				
1804	..	..	..	..	..	..	..	..	..	..	..	73·1*	..
1810	..	..	..	..	..	..	..	..	..	..	..	..†	..
1816	..	..	..	..	..	..	..	..	..	..	..	46·4*	..
1823	..	..	..	..	..	..	..	..	..	..	..	1·8†	..
1830	..	..	..	..	..	..	..	..	..	..	..	70·7*	..
1833	..	..	..	..	..	..	..	..	..	..	..	8·5†	..
1837	..	..	..	..	..	..	..	..	..	..	..	138·2*	..
1839	21·8	..	..	..	..	..	..	..	..	..	..	10·7†	A.
1843	21·2	..	..	..	..	..	..	..	..	..	..	..	..
1845	20·9	..	..	..	..	..	..	..	..	..	..	..	P.
1848	24·7	..	..	..	..	..	..	..	..	..	..	124·3*	..
1851	22·0	20·8	..	..	..	..	..	..	..	..	..	..	A.
1853	22·9	23·7	..	..	..	..	..	..	..	..	..	..	..
1856	20·5	21·8	..	..	..	..	..	..	17·80	..	..	4·3†	P.
1857	21·8	23·7	..	..	..	..	..	..	17·10	..	..	..	..
1860	21·2	17·6	..	..	..	..	..	..	19·92	..	..	95·7*	..
1861	21·6	18·5	..	..	..	..	..	..	16·36	23·4	..	77·2	..
1862	21·4	21·4	..	..	..	..	..	..	15·01	23·1	..	59·1	A.
1863	23·0	19·3	..	..	..	..	..	..	15·49	24·4	..	44·0	..
1864	23·7	20·2	..	..	..	..	..	..	15·34	25·5	..	46·9	..
1865	23·2	19·4	16·97	16·41	14·30	21·42	..	15·13	13·40	26·0	16·3	30·5	..
1866	23·4	20·0	19·37	17·47	17·20	25·67	..	12·86	14·19	28·8*	17·7*	16·3	..
1867	21·7	19·6	18·06	19·64	17·48	17·80	..	12·78	14·44	25·5	16·7	7·3†	..
1868	21·8	21·0	15·00	15·83	14·41	17·36	..	11·94	14·75	25·9	14·9	37·3	P.
1869	22·3	22·3	15·47	14·05	12·37	16·20	..	11·73	13·24	25·4†	13·8	73·9	..
1870	22·9	19·8	14·61	13·27	13·94	14·59	..	11·13	14·08	26·1	13·6*	139·1*	..
1871	22·6	17·2	13·46	12·54	12·87	14·83	..	10·13	13·46	27·0	12·9†	111·2	..
1872	21·3	16·3	14·38	14·11	15·33	14·97	14·02	11·68	13·83	25·4	14·0	101·7	..
1873	21·0	17·2	15·02	13·84	13·48	16·06	16·24	12·67	14·60	27·4*	14·6	66·3	..
1874	22·2	20·3	15·72	15·12	17·05	17·98	18·74	13·05	16·22	25·0	16·3	44·6	A.
1875	22·7	20·2	19·42	18·09	19·45	23·80	17·88	15·92	20·01	25·4	19·2*	17·1	..
1876	20·9	19·5	17·02	18·11	16·28	18·82	14·18	12·66	16·87	24·3	16·2	11·3	..
1877	20·3	18·5	15·80	15·28	13·99	17·29	15·70	11·47	19·19	23·9	15·5	12·3	..
1878	21·6	18·0	15·46	15·88	15·44	20·41	14·07	11·01	15·67	24·2	15·4	3·4†	..
1879	20·7	16·9	14·53	14·29	14·09	14·97	14·46	12·46	15·18	23·7	14·3	6·0	..
1880	20·6	18·1	13·70	15·57	14·85	13·59	13·24	11·46	16·12	24·29	14·0†	32·3	P.
1881	18·9	17·7	14·16	15·12	14·49	15·02	13·80	11·13	14·77	23·30†	14·0†	54·2	..
1882	19·6	17·4	15·11	16·03	15·15	17·99	14·16	11·19	15·79	23·51	15·2	..	..
1883	19·5	17·3	14·18	14·57	14·86	18·82	17·93	11·45	17·06	22·93	14·45	..	..
1884	19·6	17·5	14·27	15·88	15·24	22·97	21·87	10·39	15·50	20·5	15·09	..	..
1885	19·0	17·8	14·73	16·42	12·48	19·58	17·61	10·76	15·40	21·5	14·83	..	..
1886	..	..	..	..	..	..	..	..	14·58	..	..	..	..

* Maximum years.   † Minimum years.