Focus on Adult Mortality[1]

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The expectation of life at birth (e_o) is generally considered to be the indicator which best summarizes the mortality conditions of a population. Though correct in the actuarial sense, when viewed in the context of society, an actually living population, it insufficiently reflects adult mortality.

The importance of a currently living person to the current e_o equals e_x of his own age x. This is the difference that his death or survival makes to the current life expectancy at birth. Under most mortality conditions now prevailing in the world, the level of e_o is about twice that of e_{30} or e_{35}. For the calculation of e_o then, the death of a person in his/her thirties — more often than not either a mother of small children or a family breadwinner or both in the same person — is only half as great a loss as the death of their newborn child. For the family and the surviving children, however, it may be a calamity and to the community at large a keenly felt loss. It has to be concluded, therefore, that the expectation of life at birth, though it is the foremost and indispensable indicator of mortality conditions, may describe them very inadequately when used alone.

It follows that it is necessary to measure adult mortality independently from childhood mortality. This, of course, is regularly done: age-specific death rates are calculated by many variables including the cause of death and are used for in-depth analysis of mortality. The problem is that because there is no neat, summary indicator of adult mortality comparable to the life expectancy at birth or to the infant mortality rate or even to the crude death rate, adult mortality is rarely mentioned when the demographic situation of a country is assessed. As a result, adult mortality receives little attention and is often not considered a national problem. Cause-specific medical studies may lead to intervention programmes mainly in the more advanced countries but the overall view is rarely obtained even there. Instead, data users and decision makers are taught to monitor health progress through gains made in the life expectancy at birth per any 5- or 10-year period and this leads to neglect of adult mortality problems.

Often the quite erroneous view is held that adult mortality is no major problem, or that little can be done about it. Yet, as will be shown below, even in the third world the adult mortality causes a larger number of untimely deaths than the child mortality. The relative proportions, moreover, vary widely between countries indicating that the size of adult mortality is neither uniform nor immutable.

A separate indicator of adult mortality would not be so badly needed if e.g. the life expectancy at birth or the infant mortality was so closely correlated with it that they could be used as surrogates. This, however, is not the case. Mortality patterns vary geographically and often undergo rapid changes in time as causes of death re-

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spond differentially to new methods and programmes of sanitation, preventive and curative medicine and to a changing environment, diet, habits and living conditions. It is shown later in this paper that an adequate adult mortality indicator does not correlate closely with well-known, more general mortality indicators.

Delimitation of adult life

Since childhood mortality is commonly understood to cover the first fifteen years of life, we shall take the adult mortality to begin at the exact age of 15 years. Adulthood is, of course, variously defined in different countries and for different legal, social or other purposes but in life table analysis quinquennial age groups should be respected for practical reasons and in such case 15 years is perhaps the generally most suitable lower limit, particularly as it is used for such concepts as dependency ratio and working age.

Under this definition of adulthood, the most comprehensive — though inverse — measure of mortality is the expectation of life at exact age 15:

$$e_{15} = \frac{T_{15}}{l_{15}} \tag{1}$$

This does not, however, sufficiently explain the mortality. First of all, many policy makers and data users would wish to concentrate more on either the economically or the functionally active population and pay less attention to persons of very old age since little can be done for their survival. Or, it may be thought preferable to separate the very old into a special category with its own particular problems. Secondly, after a certain age which may be 65, 75, 80 or 85, the basic data often become increasingly unreliable or insufficient in numbers for the calculation of the probabilities of dying. Consequently, the age of 75 is often the upper limit of the highest closed age group in a life table. Even when q_x values are calculated for higher ages, they are in many countries weaker, in some instances only conjectural and sometimes based on model life tables and thus of little inherent value. Thirdly, for many purposes it is desirable to indicate the *expected loss of life* instead of the *expected life* because (i) it describes the health problem directly and in its real dimensions; (ii) it can be divided into components by cause of death and (iii) to strive towards zero is understood better than to strive towards a ceiling equal to an arbitrarily determined span of life. But loss of life can only be measured against a notion of potential life. In the absence of a generally accepted definition of the »natural» or potential life span in a way that allows of individual variation — as in the sense of the Gompertz-Makeham formula — it is necessary to select a single upper limit. In order to conform even to abridged life tables and generally published statistics, the cut-off age should be divisible by 5 and should not be so high as to include ages for which the basic data are often questionable.

If a cut-off limit of 65 years is selected, the indicator will give the expected years of working age for a person aged 15 or, inversely, the expected loss of working years. It seems, however, desirable to move away from a too exclusively economic concept towards a wider, more general and more human view of adult life which would also serve health concerns better. In demographic life tables no discrimination is made between those who belong to the labor force and those who don't and there is therefore not much reason to use this as a cut-off criterion.

If would seem meaningful to select as the upper limit an age to which people in general can reasonably aspire to live, a »natural» age before which a death can be called untimely. This could be represented by the mode of the d_x function, i.e. the age at which the largest number of adult deaths occur in a stationary population. In 24 medium-mortality countries we found this age to be about 74 years for males (as a median) and 78 for females, and in 35 low-mortality countries about 77 for males and over 80 for females. In high-mortality countries the modal age is lower but the scarcity of data makes it difficult to pinpoint it.

In the 1930s the classification in use in Finland included senile debility as an acceptable cause of death and in 1936—40 12.2 % of all deaths, excluding war deaths, were ascribed to it. On the basis of the statistics for the said period, Kannisto calculated that if senile debility was the only cause of death, the average expectation of life at birth, for the two sexes combined, would be almost exactly 85 years and so would be the mode of d_x (Kannisto 1947).

If now a uniform global age limit, the same for both sexes, is required, then 75 years seems to be relatively central. For low-mortality countries a higher limit, such as 80 or 85 years, could be applied since reliable data are available to that age and beyond but it should be kept in mind that a high age limit will shift the indicator towards problems of old age and will include increasing numbers of unavoidable deaths.

Another criterion could be the preventability of death. We might consider what is preventable by the general application of reasonable standards of environmental hygiene, immunization, health education and basic health services including the more accessible methods of therapy and perhaps the most common surgical interventions. Major surgery and intensive care, of course, prevent or delay many deaths but even in the most developed countries their numerical effect at old ages is relatively minor. The age of 75 years would appear to be close to the age below which most deaths would be preventable. While this might seem rather high in developing countries as of now, it could be a realistic medium or long range goal.

As yet another approach we might consider until what age an average person is still useful to his family, his associates or to the community or, to express it differently, until when does he give them more than what he receives from them — and not only in the material sense. In still other words: until when is he/she a net contributor to the family, the fellow people, the community or even to mankind. No limit would ever fit all persons or all populations but again it would seem that the limit should not be less than 75 years.

Finally, it is necessary to consider the practical aspects of the calculations and the constraints of available data which are most compelling for subnational and cause-of-death information, often available only by 10-year age groups ending in 5.

In the following, therefore, 75 years is used as the upper limit of the age span for which a general-purpose adult mortality indicator is constructed, while it is understood that a higher limit, such as 80 or 85, might suit low-mortality countries.

An adult mortality indicator

On the basis of what is said above, a suggestion is made in the following for a synthetic measure of adult mortality which could be used to complement the basic e_{15}.

The expectation of life of a 15-year old before age 75 can be obtained from a life table and expressed as follows:

$$_{60}e_{15} = \frac{T_{15} - T_{75}}{l_{15}} \qquad (2)$$

in which 60 denotes the width of the age group 15—74.

In order to obtain the advantages of a direct measure of mortality instead of survival, this value has to be subtracted from the maximum possible which is 60 years, in order to obtain the loss of years of life. As most of the letters of the alphabet have been pre-empted for other life table functions or other well-established roles, the loss of life-years shall be denoted by w for »wastage».

We now have

$${}_{60}w_{15} = 60 - {}_{60}e_{15} \quad (3)$$

This indicates the *mean loss of life-years a person of age 15 shall expect before age 75* and it can be interpreted as an approximate measure of the *loss of adult life through untimely death* or, from another point of view, *through preventable death*.

The question may be asked whether this indicator is biased in favor of younger ages in the same way as the life expectancy at birth. It can be noted that, first of all, the shorter age span in equation (3) reduces the inequality and that, secondly, there is some justification for considering the death of a young adult a greater loss than that of one reaching old age, even if not necessarily in direct proportions to their resp. distances from age 75. The inevitable arbitrariness of a summary indicator is in this case mitigated by the fact that the mortality of young adults is in normal times quite low and has therefore relatively little effect on the indicator.

The loss of life so expressed can be attributed to different causes of death and thus become a valid measure of differential or changing adult mortality conditions and of the success of health programmes.

The global situation

To illustrate the levels of adult mortality in the world at present, the proposed indicator was calculated for each sex for 63 countries for which the necessary underlying data were published either in the United Nations Demographic Yearbook 1980 (the latest one with the requisite information) or among the country life tables on which the United Nations Model Life Tables for Developing Countries were based. Only one, the latest, life table for each country was included in the comparison given in Appendix Table.

In this table, the countries have been arranged in descending order of their female life expectancy at birth which seems to well correspond to the generally held image of the health standards in a country; the ranking of this indicator is given in the last column and, as can be seen, varies somewhat from the corresponding male indicator.

The losses from adult mortality before age 75 range, depending on the country, from 5 or 6 years for males and 3 years for females to more than 15 years for each sex. Japan emerges as the country of lowest adult mortality, followed closely by Netherlands, Norway, Sweden and Iceland. Also Switzerland, Denmark and England and Wales have low rates. Certain other countries with generally low mortality, however, have quite high adult rates, notably Finland, France and Austria for males and the United States, Scotland and Northern Ireland for both sexes. Czechoslovakia and Hungary also display high death rates for adult males. In contrast with these more northern countries, low or moderate adult mortality can be noted in the Mediterranean region, particularly in Italy, Spain, Yugoslavia and Malta but also in Portugal for females. The life tables for Greece in 1970 and Cyprus in 1976—77 show extraordinarily low adult male rates but as they evidence some major internal irregularities, are not included in the comparison. Finally even Tunisia and Syria rank considerably better in adult than in general mortality, thus confirming the observed Mediterranean tendency.

South-East Asian countries generally have more serious adult mortality problems than one would assume on the basis of their life expectancy at birth. This is the case of Peninsular Malaysia, Sarawak, Thailand, Philippines and Hong Kong for both sexes, of Singapore for males and of Brunei for females. South Korea has, if the data are reliable, an alarmingly high adult male mortality contrasting with a moderate for females.

Costa Rica is one of the few low mortality countries in Latin America and the only one represented in the table as we had no data for Cuba. Other Central American countries, namely Guatemala, El Salvador and Honduras have high death rates for both sexes at all ages. On the Pacific coast, Peru, Ecuador and Chile as well as the males in Costa Rica and Panama rank better in adult than in general mortality. In contrast with them, in the Caribbean area the Bahamas, Trinidad and Tobago, Guyana and Venezuela display higher adult mortality than the expectation of life at birth would suggest.

When the data in Appendix Table are compared by sex, an excess female mortality is seen for India and for tiny Brunei but also nearly equal female rates in Sarawak (Malaysia) as well as in Panama, Mexico, Guatemala and Ecuador. This has to be considered a hardship situation for women because in all low-mortality countries without exception the adult mortality is much lower for females than for males, often only half of it. Another region of relative female disadvantage is the Middle East where in Tunisia, Israel, Syria, Kuwait and Iran the mortality of adult males ranks much lower than that of females.

Even this fleeting observation of the results shows that the relative positions of the countries as to adult mortality are quite different from a ranking by general mortality. Secondly, it is obvious that the sex ratio of adult mortality varies greatly from country to country and not in keeping with the sex ratio of child mortality. Thirdly, the very disadvantageous rates for almost all developing countries make it clear that far from being a concern of industrial countries alone, adult mortality is in developing countries a very serious problem which should not any longer be obscured by lack of a suitable measure.

Correlation of ${}_{60}w_{15}$ with other life table functions

Life table functions tend to be correlated with each other as they cover much of the same mortality experience. In the 63 countries here examined, ${}_{60}w_{15}$ showed the following correlation coefficients:

with e_o	for males	—0.913
	for females	—0.948
with e_{15}	for males	—0.971
	for females	—0.977

Although the correlation with e_{15} is high, it is not sufficient to justify replacement by it. In the 63 male life tables the deviations of the actual ${}_{60}w_{15}$ values from a linear regression line with e_{15} were calculated. The mean relative deviation was 4.1 % and varied as follows:

per cent deviation	No. of countries
0—2	18
2—5	20
5—10	18
10—	7
Total	63

The use of e_{15} as a proxy for ${}_{60}w_{15}$ would thus lead to considerable inprecision.

Comparison of the loss of adult life through deaths of children and of adults

In actuarial terms, adult life-years are lost through deaths which occur in childhood as well as in adult age. The first element equals 60 years per each death before age 15, namely

$$_{15}d_o \cdot 60$$

The second element is obtained by relating the adult mortality indicator to the original birth cohort:

$$\frac{l_{15}}{100{,}000} \cdot {}_{60}w_{15}$$

These values have been calculated for the 63 countries listed in Appendix Table. The percentage that the first element forms of the total, is given in Table 1. It shows that in 56 countries — 28 of which are developing countries — most of the loss of adult life was due to death in adult age while childhood mortality dominated in only seven countries: El Salvador, Guatemala, Honduras, India, Iran, Peru and Tunisia. The overwhelming importance of adult mortality to the loss of adult life-years is therefore in evidence.

T a b l e 1. Percentage of the loss of adult life-years (15—74) due to childhood mortality

Percentage	Males No. of countries	Females No. of countries
0—10	1	—
10—20	25	12
20—30	8	21
30—40	12	7
40—50	10	16
50—60	5	2
60—70	2	5
70—	—	—
Total	63	63

Loss of adult life-years according to cause of death

Data on the causes of death can be linked with a life table so as to show the loss of life-years by cause. For this we need information on causes of death by sex and age which is usually available by 5-year age groups. The average loss of life-years before age 75 per each 15-year-old from a given cause j is then obtained through

$${}_{60}w_{j_{15}} = \frac{1}{l_{15}} \sum_{x=15}^{70} (72.5-x) \frac{{}_5D_{j_x}}{{}_5D_x} \cdot {}_5d_x \qquad (4)$$

in which D denotes observed deaths by cause as follows:

${}_5D_{j_x}$ = deaths from cause j at age x to x+5

${}_5D_x$ = deaths from all causes at age x to x+5

and the last element is a life table function:

${}_5d_x$ = deaths at age x to x+5 in a birth cohort.

The values obtained this way may need an adjustment in order to add up to ${}_{60}w_{15}$ in the life table if this latter is based on single-year age data or has been smoothed.

As an illustration of the results, the adult mortality indicators for Finnish men and women in 1979 have been apportioned between the most important causes of death on the basis of vital statistics for the same year and given in Table 2 per 1000 persons of age 15.

T a b l e 2. Loss of life through death at ages 15—74 years, per 1 000 persons of age 15, by cause of death and sex. 8th Revision of ICD, A-List. Finland 1979.

Code	Cause of death	$1\,000 \cdot {}_{60}w_{15}$ Male	Female
006—010	Tuberculosis	42	21
047—049	Cancer of stomach, intestine etc.	270	192
051	Cancer of bronchus and lung	580	62
054	Cancer of breast	0	234
other II	Other tumours	648	652
064	Diabetes mellitus	74	51
V	Mental disorders	59	22
VI	Diseases of the nervous system	110	73
083	Ischemic heart disease	2 588	624
085	Cerebrovascular diseases	521	347
other VII	Other dis. of circulatory system	463	249
091—092	Pneumonia	101	48
093	Bronchitis, emphysema, asthma	162	35
oth. VIII	Other dis. of respiratory system	27	20
IX	Diseases of the digestive system	273	93
X	Diseases of the genito-urin. system	44	41
XI	Maternal deaths	—	4
AE 147	Suicide	812	200
AE 148	Homicide	85	22
AE 138	Motor vehicle accidents	344	124
other AE	Other accidents	941	143
	All other causes	129	152
	Total	8 273	3 408

Summary

The author expresses the view that the life expectancy at birth (e_0), though unquestionably correct in the actuarial sense, is an inadequate indicator of mortality conditions in an actually living population with its demographic dynamics and its social, health and human problems. For e_o the survival of a newborn child is about twice as important as the survival of a young mother with many small children or of the family breadwinner. This is surely not in accordance with the concept of community health or the goal »Health for all by the year 2000».

The social and health conditions of a country are often too exclusively monitored through the infant mortality rate or the expectation of life at birth and, as a consequence, adult mortality is neglected or ignored. Yet, adult mortality problems, by nature relatively persistent, are generally very serious in developing countries and in relative terms also in low-mortality countries.

The use of two indicators of adult mortality is proposed: first, a life table function such as e_{15} and secondly a new composite indicator ${}_{60}w_{15}$ which measures the loss of life-years through deaths occurring between the ages 15 and 75. This can be considered a measure of the *loss of life-years through untimely adult death,* »untimely» being to some extent concomitant with »preventable». It can be derived even from an abridged life table and has the advantage over e-functions that it measures mortality directly, not inversely, and thus in its real dimensions. It is sensitive to geographical differences and to changes in time. Very importantly, it can be disaggre-

gated to different causes of death. The inevitable drawback is that it has to use an arbitrarily elected upper age limit. If this limit is low, attention is focused more on younger and middle age; if it is high, the indicator is weighed down by large numbers of non-preventable deaths. The age 75 is suggested as a practical general-purpose limit. As an alternative, 80 or 85 years might be a preferred upper limit in low-mortality countries.

It is by no means suggested that infant and child mortality are receiving too much attention. The largely successful, internationally supported endeavours to reduce them are the logical and appropriate first phase in the struggle towards better health on a global scale. It is felt, though, that the seriousness of adult mortality is being obscured by the lack of a comprehensive, single indicator.

The paper presents the proposed adult mortality indicator for 63 countries and compares them with life expectancy at birth. The loss of life-years by cause of death is illustrated by an example.

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Appendix Table. Loss of life-years through death at ages 15—74 years, per person of age 15. 63 countries and areas presented in order of female life expectancy at birth.

Country or area	Years	$_{60}w_{15}$ Life-years Male	Female	Rank M	F	Rank acc. to e_o M	F
Iceland	1977—78	5.94	3.23	3	5	2	1
Netherlands	1979	5.87	3.13	2	3	4	2
Japan	1979	5.36	2.99	1	1	1	3
Norway	1978—79	6.04	3.00	5	2	5	4
Sweden	1979	6.00	3.19	4	4	3	5
France	1977—79	7.66	3.53	20	7	13	6
Australia	1979	6.91	3.62	11	8	8	7
Canada	1975—77	7.37	3.82	14	11	10	8
Denmark	1978—79	6.63	4.00	7	15	7	9
Finland	1979	8.27	3.41	31	6	19	10
U.S.A.	1978	7.98	4.24	26	21	16	11
Puerto Rico	1976	7.94	3.92	24	13	11	12
Hong Kong	1976	7.41	4.15	16	18	15	13
England & Wales	1976—78	6.75	3.99	9	14	12	14
Switzerland	1968—73	6.68	3.65	8	9	9	15
Austria	1979	7.95	3.71	25	10	21	16
Germany, Fed.Rep.	1976—78	7.52	4.04	17	16	17	17
Belgium	1972—76	7.62	4.17	19	19	23	18
Israel	1978	6.19	4.23	6	20	6	19
Spain	1970	6.77	4.09	10	17	14	20

Country or area	Years	${}_{60}w_{15}$ Life-years Male	${}_{60}w_{15}$ Life-years Female	${}_{60}w_{15}$ Rank M	${}_{60}w_{15}$ Rank F	Rank acc. to e_o M	Rank acc. to e_o F
Italy	1970—72	6.96	3.90	12	12	18	21
New Zealand	1970—72	7.78	4.65	22	26	24	22
Scotland	1976—78	8.09	4.98	28	31	26	23
Northern Ireland	1976—78	8.20	4.71	30	27	27	24
Czechoslovakia	1977	8.61	4.37	35	23	29	25
Bulgaria	1974—76	7.14	4.36	13	22	22	26
Hungary	1979	8.85	4.80	38	28	30	27
Ireland	1970—72	7.37	4.89	15	29	20	28
Malta	1976	7.58	4.57	18	25	25	29
Malaysia, Penins.	1978	8.72	6.27	37	37	28	30
Portugal	1974	8.44	4.49	34	24	34	31
Costa Rica	1972—74	7.67	5.36	21	33	31	32
Kuwait	1974—76	7.91	5.22	23	32	32	33
Yugoslavia	1970—72	8.13	4.97	29	30	33	34
Singapore	1970	9.16	5.65	41	34	35	35
Argentina	1969—71	10.09	5.65	46	35	44	36
Venezuela	1975	8.92	6.30	39	38	36	37
Bahamas	1969—71	10.73	7.91	50	47	39	38
Korea, Rep.	1978—79	10.74	5.81	51	36	43	39
Trinidad & Tobago	1970	9.20	7.43	42	42	38	40
Chile	1975—80	9.92	6.97	44	40	46	41
Panama	1970	8.39	7.59	32	44	37	42
Sri Lanka	1970—72	8.75	6.92	36	39	40	43
Mexico	1975	8.39	7.38	33	41	42	44
Greenland	1971—75	11.67	8.86	57	51	47	45
Syria	1977	8.00	7.62	27	45	41	46
Mauritius	1971—73	10.16	7.49	47	43	48	47
Philippines	1969—71	11.60	8.31	56	49	52	48
Guyana	1959—61	11.58	9.75	55	55	51	49
Samoa	1966—71	11.24	9.27	54	54	49	50
Brunei	1970—72	9.41	10.45	43	59	45	51
Ecuador	1974—79	10.23	9.04	48	53	50	52
Brazil	1960—70	11.01	9.17	53	53	54	53
Thailand	1969—71	12.35	10.10	60	57	56	54
El Salvador	1970—72	10.90	7.71	52	46	57	55
Colombia	1963—65	11.74	9.90	58	56	53	56
Peru	1969—71	10.00	8.35	45	50	59	57
Iran	1973—76	8.93	8.25	40	48	55	58
Guatemala	1972—73	12.11	11.13	59	60	58	59
Honduras	1973—75	14.52	11.25	62	61	62	60
Malaysia, Sarawak	1970	15.87	15.69	63	63	61	61
Tunisia	1968—69	10.53	10.26	49	58	60	62
India	1970—72	12.97	14.08	61	62	63	63