Calculating life expectancy and infant mortality rates

Mapping health inequalities across London: technical supplement

Introduction

This report provides a technical description of the analysis presented and data used in the report *'Mapping health inequalities across London'.* The main report presents a local analysis of the two national health inequalities targets. A further report *'What do the health inequalities targets mean for London?'* answers some common questions that have been asked about the main report and the results presented. Both of these documents are available from the London Health Observatory website www.lho.org.uk. If you would like any further information please contact Justine Fitzpatrick by email, justine.fitzpatrick@lho.org.uk or by telephoning 020 7307 2829.

The two national health inequalities targets are as follows:

Box 1 The national health inequalities targets

1. Infant mortality (deaths in the first year of life)

Starting with children under one year, by 2010 to reduce by at least 10 per cent the gap* in mortality between manual groups and the population as a whole.

2. Expectation of life

Starting with health authorities, by 2010 to reduce by at least 10% the gap* between the fifth of areas with the lowest life expectancy at birth and the population as a whole.

---

* Both of these targets refer to a reduction in the projected relative gap in 2010.

Life expectancy

The advantage of using life expectancy as an indicator of health inequalities is that it is an all-age summary measure of mortality that does not require the use of a standard population. Therefore, the output obtained is not dependent on which standard population is used. It is also easily comparable between areas, including other countries. In addition it is a measure of mortality that is more easily understood by the general population.

Definition

Expectation of life can be defined as

'the number of years a baby born in a particular area or population can be expected to live IF it experienced the current age-specific mortality rates of that particular area or population throughout its life'.

For example it is the number of years a baby boy would be expected to live if it experienced the age-specific mortality rate of the < 1 age group when it was under 1, the 1-4 age group when it was 1-4 and so on until age 85+.

Therefore, average life expectancy is an estimate of how long a baby would be expected to live **if** current age-specific mortality rates remain constant. It is not a forecast of how long babies born will actually be expected to survive as it is unlikely that age-specific mortality rates will remain constant for an extended length of time. It is best interpreted as a summary measure of mortality like any other.

Calculating life expectancy

Life expectancy is calculated by constructing a life table. Life tables are a series of columns of data, the only raw data needed are the population and the number of deaths (or the age-specific death rates). All other columns of data and the expectation of life are calculated from these.

Data in this report have been calculated using 'abridged' life tables. That is that the data is input into the life table in five-year age bands and not single years of age.

Data needed

The only data needed to calculate life expectancy for a particular geographic area or for a particular group of the population are:

1. population in 5 year age bands
2. deaths in 5 year age bands

From this you need to calculate the age specific death rates in the usual way

Deaths
─────
Population

Example 1 Calculating age-specific death rates

Age group	3 year population	deaths in 3 years	Age-specific death rate
<1	27329	135	0.005
1-4	104732	31	0.000
5-9	124464	6	0.000
10-14	108681	17	0.000
15-19	106607	41	0.000
20-24	137071	79	0.001
25-29	179225	131	0.001
30-34	208744	160	0.001
35-39	180626	196	0.001
40-44	136890	221	0.002
45-49	122731	336	0.003
50-54	117275	545	0.005
55-59	87437	695	0.008
60-64	74925	992	0.013
65-69	63935	1529	0.024
70-74	52615	2136	0.041
75-79	42035	2695	0.064
80-85	24402	2613	0.107
85+	18952	3377	0.178

In our report we have combined 3 years of data to complete our analysis. This increases the number of deaths for a particular age band and improves the accuracy of our estimation of expectation of life.

Detailed calculations and column definitions

A standard abridged life table is presented in Example 2. This section goes through the calculation of each individual column.

Width of the interval ($_n$)

The number of years in each age interval. For example for the <1 age group $n = 1$, for the 1-4 age group $n = 4$ and for all other age groups including 85+ $n = 5$.

Average proportion of the year lived by those who die ($_na_x$)

Usually it is assumed that death occurs uniformly across time and that on average people will live 0.5 of the interval before death. However, there are some cases where we know that death does not occur uniformly across time within age groups. For example, for those aged under 1 we assume that the average proportion of the year lived by those who die is 0.1.

The probability of dying ($_nq_x$)

$$\frac{\text{Number of years in interval * age-specific death rate}}{1 + \text{number of years in interval (1 – average proportion of year lived by those who die)*age specific death rate}}$$

<u>or</u>

$$\frac{n * _nM_x}{1 + _n(1 - _na_x) * _nM_x}$$

The probability of surviving ($_np_x$)

1 – probability of dying

<u>or</u>

$1 - _nq_x$

Number of persons alive at the start of the interval (l_x)

This is a hypothetical population, in this case 100,000 alive/born at age 0. Those alive at age 1-4 in this case are:

Probability of surviving the previous interval * population alive at start of previous interval

<u>or</u>

$l_{x-n} * _np_{x-n}$

Number of deaths during interval ($_nd_x$)

Population alive at start of interval – population alive at start of next interval

<u>or</u>

$l_x - l_{x+n}$

Number of person years lived through the interval ($_nL_x$)

Number of years in interval (number of persons alive at start of next interval + average proportion of year lived by those who die*number of deaths during interval)

<u>or</u>

$_n(l_{x+n} + {_na_x} * {_nd_x})$

At age 85+ everybody dies during the interval so an adjustment has to be made. Whatever is used as an estimate of the number of years lived has little impact on overall life expectancy, however, it is usual to use the following estimate:

$$L_{85+} = \frac{l_{85}}{M_{85+}}$$

Total number of person years lived after the interval ($_nT_x$)

This is the 'number of person years lived through the interval' column summed from the bottom.

<u>or</u>

$T_{x+n} + {_nL_x}$

Expectation of life (e_x)

This is the number of years a person aged x can be expected to live.

$$\frac{\text{Total number of person years lived after the interval}}{\text{Number of person years alive at the start of the interval}}$$

<u>or</u>

$$\frac{T_x}{l_x}$$

Example 2 Standard abridged life table

Age group	3 year population	deaths in 3 years	Age-specific death rate	Average proportion of year lived by those who die	Probability of dying during the interval	Probability of surviving the interval	Number of persons alive at the start of the interval (hypothetical population)	Number of deaths during the interval (hypothetical population)	Number of person years lived through the interval	Total number of person years lived after the interval	Expectation of life
	$_nP_x$	$_nD_x$	$_nM_x$	$_na_x$	$_nq_x$	$_np_x$	l_x	$_nd_x$	$_nL_x$	T_x	e_x
<1	27329	135	0.005	0.1	0.005	0.995	100000	492	99557	7594872	75.9
1-4	104732	31	0.000	0.5	0.001	0.999	99508	118	397797	7495315	75.3
5-9	124464	6	0.000	0.5	0.000	1.000	99390	24	496892	7097518	71.4
10-14	108681	17	0.000	0.5	0.001	0.999	99367	78	496638	6600625	66.4
15-19	106607	41	0.000	0.5	0.002	0.998	99289	191	495967	6103987	61.5
20-24	137071	79	0.001	0.5	0.003	0.997	99098	285	494777	5608020	56.6
25-29	179225	131	0.001	0.5	0.004	0.996	98813	360	493163	5113242	51.7
30-34	208744	160	0.001	0.5	0.004	0.996	98452	377	491321	4620079	46.9
35-39	180626	196	0.001	0.5	0.005	0.995	98076	531	489053	4128758	42.1
40-44	136890	221	0.002	0.5	0.008	0.992	97545	784	485765	3639705	37.3
45-49	122731	336	0.003	0.5	0.014	0.986	96761	1316	480516	3153940	32.6
50-54	117275	545	0.005	0.5	0.023	0.977	95445	2192	471746	2673424	28.0
55-59	87437	695	0.008	0.5	0.039	0.961	93253	3634	457181	2201678	23.6
60-64	74925	992	0.013	0.5	0.064	0.936	89619	5743	433739	1744497	19.5
65-69	63935	1529	0.024	0.5	0.113	0.887	83877	9464	395723	1310757	15.6
70-74	52615	2136	0.041	0.5	0.184	0.816	74413	13713	337782	915034	12.3
75-79	42035	2695	0.064	0.5	0.276	0.724	60700	16770	261574	577252	9.5
80-85	24402	2613	0.107	0.5	0.422	0.578	43930	18553	173265	315678	7.2
85+	18952	3377	0.178	0.5	0.616	0.384	25376	25376	142413	142413	5.6

Confidence intervals

Standard methods for the calculation of the confidence interval for average life expectancy have been use. Further details are available from:

Smith D. *Formal demography.* Plenum Press (New York: 1992)

Chiang CL. *The life table and its applications.* Robert E Krieger Publishing Company (Florida: 1984)

Further details

Further details on the calculation of life expectancy is available from:

Newell C. *Methods and models in demography.* John Wiley and Sons (Chichester: 1994)

Shyrock HS and Siegel JS. *The methods and materials of demography.* Academic Press (New York: 1976)

Bland M. An introduction to medical statistics. Oxford Medical Publications (Oxford: 1992)

We have also made available a template for calculating life expectancy for local areas and local populations via our website http://www.lho.org.uk. This template is available for use in Microsoft Excel.

Infant mortality

Definition

The infant mortality rate is defined in this paper as the number of infant deaths (deaths in the first year of life) to those born in a particular year per 1000 live births in that year.

Data used in this report

The infant mortality data used in this report are taken from the ONS linked infant mortality file. This file links information collected at birth registration such as father's occupation, birthweight, mother's country of birth, mother's age and registration type (outside marriage - sole registration, outside marriage –joint registration, inside marriage) with information collected at death registration such as age at death, cause of death and father's occupation.

The information used in this report is taken from the birth cohort files. That is it takes all births in a calendar year and links in the information from the death registration for all those babies that have died before their first birthday.

Area of residence

Area of residence is defined at birth and therefore infant mortality rates for particular areas will include some deaths to infants who have moved out of the area after birth.

Allocating social class to births and deaths

Social class at birth is determined by father's occupation and employment status at birth and social class at death is determined by father's occupation and employment status at death. Box 2 provides a breakdown of the social class groups. This classification was devised by the Registrar General for England and Wales 1911. The manual groups are made up of Social Class IIIm (skilled manual), Social Class IV (partly skilled) and Social Class V (unskilled).

	Box 2 Social Class (based on occupation)	
I	Professional (e.g. accountants, electronic engineers)	
II	Managerial and technical/intermediate (e.g. proprietors and managers – sales, production, works and maintenance managers)	
IIIn	Skilled non-manual (e.g. clerks and cashiers – not retail)	
IIIm	Skilled manual (e.g. drivers of road goods vehicles, metal working and production fitters)	
IV	Partly skilled (e.g. storekeepers and warehousemen, machine tool operators)	
V	Unskilled (e.g. building and civil engineering labourers, cleaners)	

Calculating infant mortality rates

The infant mortality rate is defined in this paper as the number of infant deaths to those born in a particular year per 1000 live births in that year.

$$\frac{\text{Number of infant deaths to those born in year y}}{\text{Number of live births in year y}} \times 1000$$

Infant mortality rate for manual groups

$$\frac{\text{Number of infant deaths to those born in year y where father's Social Class at death is IIIm, IV or V}}{\text{Number of live births in year y where father's Social Class at birth is IIIm, IV or V}} \times 1000$$

Infant mortality rate for population as a whole

$$\frac{\text{Number of infant deaths among those born in year y and were inside marriage or jointly registered}}{\text{Number of live births in year y inside marriage or jointly registered}} \times 1000$$

Confidence intervals

Standard methods for the calculation of a confidence interval for a proportion have been used to calculate confidence intervals around the infant mortality rate. This is available in most standard statistical textbooks including:

Kirkwood B. *Essentials of medical statistics.* Blackwell Scientific Publications (Oxford: 1988)

Bland B. *An introduction to medical statistics.* Oxford University Press (Oxford: 1989)

Further details

Further details on the ONS infant mortality linked file is available from:

Office for National Statistics. *Mortality statistics, Childhood, infant and perinatal – Series DH3 no 32 1999.* The Stationery Office (London: 2001)