

Health Inequalities Intervention Tool. Technical Document

1 Introduction

This paper describes the data and methods used in the Health Inequalities Intervention Tool to calculate the effect of four interventions on life expectancy.

The tool itself can be accessed here:

http://www.lho.org.uk/HEALTH_INEQUALITIES/Health_Inequalities_Tool.aspx

A set of Frequently Asked Questions is also available

2 Derivation of the Most Deprived Quintile (MDQ) of the Local Authority

The tool considers the impact of interventions when applied to both the local authority as a whole, and in the most deprived quintile (MDQ) of the local authority. The areas which fall into the most deprived quintile were derived by ranking the lower super output areas (LSOAs) in each local authority according to income deprivation, then splitting these into five equal groups. This methodology is consistent with that used in the Health Profiles 2007.

3 The contribution of diseases to the life expectancy gap

The purpose of this part of the tool is to demonstrate by how many years life expectancy (male and female separately) would increase or decrease in the most deprived fifth of each local authority in England if it had the same mortality rates as each of five other comparator areas. The comparator areas are;

- 1) England as a whole
- 2) England's least deprived fifth of areas
- 3) The local authority as a whole
- 4) The rest of the local authority (excluding the most deprived fifth)
- 5) The local authority districts least deprived fifth of areas.

Life expectancy at birth was calculated using the SEPHO Life Expectancy Template (<http://www.sepho.org.uk/viewResource.aspx?id=8943>). The template is an abridged life table that uses 5-year intervals with the first age interval of 0-1 years and a final age interval of 85+ years. Deaths and population counts in these age-intervals are entered into the template to generate life expectancy figures for males and females separately.

The sex and age-specific expected number of deaths that would occur in the most deprived quintile of each local authority if it had the same mortality rate (for each of 31 specific causes of death) was calculated using the below formula.

$$\left(\begin{array}{c} \text{Deaths from all} \\ \text{causes in the} \\ \text{LAD MDQ} \end{array} \right) - \left(\begin{array}{c} \text{Deaths from the} \\ \text{specific cause in} \\ \text{the LAD MDQ} \end{array} \right) + \left(\begin{array}{c} \text{Death rate from the} \\ \text{specific cause in the} \\ \text{comparator area} \end{array} * \begin{array}{c} \text{Population in} \\ \text{the LAD MDQ} \end{array} \right)$$

This number of deaths was then used to calculate life expectancy in the LA most deprived quintile if it had the same mortality rate as the comparator area for each of 31 different cause of death categories.

Subtracting this adjusted life expectancy from actual life expectancy gives the number of years that life expectancy would increase or decrease in the LA most deprived quintile if it had the same mortality rate as the comparator area.

The charts only show values where there is excess mortality in that disease or age group (ie where life years would be gained by having the same mortality rate as the comparator population).

4 Impact of interventions on life expectancy.

4.1 Data used by the tool

The table below contains information on the raw data that is used by the tool, including its source, time period and geographical area covered and any calculations performed, where appropriate. Where possible, links to the data are provided.

Data	Time period	Geographical area	Source and additional details
Life expectancy at birth	2001-05	LA and MDQ	ONS death registration data and mid year population estimates for 2001 - 2005 summed. Life expectancy was calculated using the SEPHO life expectancy calculator: http://www.sepho.org.uk/viewResource.aspx?id=8943
Number of deaths from all causes	2001-05	LA and MDQ	ONS death registration data for 2001 - 2005 summed.
Population	2001-05	LA and MDQ	ONS mid year population estimates for 2001 - 2005 for Local authorities and lower super output areas, summed and rounded to the nearest 100.
Number of 4 week smoking quitters	2005/06		NHS Information Centre: http://www.ic.nhs.uk/pubs/sss0506/stopsmokinexcel/file

Data	Time period	Geographical area	Source and additional details
			Figures were available at PCT level only. No data is provided in the tool for LAs that are not coterminous with PCT(s).
Smoking prevalence	2004	LA and MDQ	<p>Health Survey for England (HSE) 2004: http://www.ic.nhs.uk/pubs/hlthsvyeng2004upd</p> <p>Linear regression of IMD (for the LA and the MDQ) and smoking prevalence calculated.</p> <p>Age specific smoking prevalence rates for each area were calculated using HSE prevalence values and the linear regression equation.</p>
Ex-smoking prevalence	2004	LA	<p>Health Survey for England (HSE) 2004: http://www.ic.nhs.uk/pubs/hlthsvyeng2004upd</p> <p>Calculated from smoking prevalence values above, assuming that ex-smoking to smoking ratio is constant throughout England.</p>
Relative risk of mortality in smokers compared to never smokers	n/a	n/a	<p>Doll R, Peto R, Boreham J, Sutherland I. Mortality in relation to smoking: 50 years' observations on male British doctors; Br Med J 2004;328:1519.</p> <p>The relative risk was calculated from figures provided in the paper as:</p> $\frac{\text{Annual mortality rate for smokers}}{\text{Annual mortality rate for never smokers}}$ <p>The tool assumes that there is no variation in relative risk by geography or sex, and that there is no increased risk of mortality from smoking in people aged under 35.</p>
Relative risk of mortality in ex-smokers compared to never smokers	n/a	n/a	<p>Doll R, Peto R, Boreham J, Sutherland I. Mortality in relation to smoking: 50 years' observations on male British doctors; Br Med J 2004;328:1519.</p> <p>The relative risk was calculated from figures provided in the paper as:</p> $\frac{\text{Annual mortality rate for ex-smokers}}{\text{Annual mortality rate for never smokers}}$ <p>The tool assumes that there is no variation in relative risk by geography or sex, and that there is no increased risk of mortality from smoking in people aged under 35.</p>
Prevalence of	2003	LA	Health Survey for England (HSE) 2003.

Data	Time period	Geographical area	Source and additional details
CHD/stroke			<p>http://www.dh.gov.uk/PublicationsAndStatistics/Publications/PublicationsStatistics/PublicationsStatisticsArticle/fs/en?CONTENT_ID=4098712&chk=F4kphd</p> <p>The tool assumes there is no variation by geography.</p>
Prevalence of CHD/stroke	2003	MDQ	<p>Health Survey for England (HSE) 2003.</p> <p>http://www.dh.gov.uk/PublicationsAndStatistics/Publications/PublicationsStatistics/PublicationsStatisticsArticle/fs/en?CONTENT_ID=4098712&chk=F4kphd</p> <p>Age specific prevalence figures were adjusted to take into account the higher prevalence of CHD and stroke in more deprived areas.</p> <p>The tool assumes there is no variation by geography.</p>
Prevalence of hypertension (undiagnosed and diagnosed and uncontrolled hypertension)	2001-05	LA and MDQ	<p>Based on the APHO Hypertensive Prevalence Estimates Model</p> <p>http://www.apho.org.uk/apho/viewResource.aspx?id=4628</p>
Relative risk of CHD in those with a history of CHD/stroke	n/a	n/a	<p>Shaper AG, Pocock SJ, Walker M, Phillips AN, Whitehead TP, Macfarlane PW. Risk factors for ischaemic heart disease: the prospective phase of the British Regional Heart Study. J Epidemiol Community Health 1985;39:197-209</p> <p>The figure provided in this paper was reduced to take into account the effect of existing treatment, methodology developed by the Department of Health.</p> <p>The tool assumes that there is no variation by geography, sex or age.</p>
Relative risk of stroke in those with a history of CHD/stroke	n/a	n/a	<p>Wolf PA. Probability of stroke: a risk factor profile from the Framingham study. Stroke 1991;22:312-8.</p> <p>The tool assumes that there is no variation by geography, sex or age.</p>
Relative risk of CHD/stroke in hypertensives	n/a	n/a	<p>MacMahon S, Peto R, Cutler J, Sorlie P et al. Blood pressure, stroke and coronary heart disease: Part 1, prolonged differences in blood pressure: prospective observational studies corrected for the regression dilution bias. Lancet 1990;335:765-74.</p>

Data	Time period	Geographical area	Source and additional details
compared to normotensives			The tool assumes that there is no variation by geography, sex or age.
Proportion of CHD/stroke deaths prevented by treatment with anti-hypertensives	n/a	n/a	Law M, Wald N, Morris J. Lowering blood pressure to prevent myocardial infarction and stroke: a new preventive strategy. Health Technol Assess 2003;7(31). The tool assumes that each person treated with an antihypertensive will experience a 5mmHg reduction in their diastolic blood pressure. The tool assumes there is no variation by geography, sex or age.
Number of CHD deaths	2001-05	LA and MDQ	ONS death registration data for 2001-05, summed. ICD10 codes I20-I25
Number of stroke deaths	2001-05	LA and MDQ	ONS death registration data for 2001-05, summed. ICD10 codes I60-I69
Proportion of CHD/stroke deaths prevented by treatment with statins	n/a	n/a	Heart Protection Study Collaborative Group. MRC/BHF Heart protection study of cholesterol, lowering with simvastatin in 20256 high risk individuals: a randomised placebo-controlled trial. Lancet 2002;360:7-22 The tool assumes that there is no variation by geography, sex or age.
Estimated number of people with undiagnosed or uncontrolled hypertension but not CVD	2004	LA and MDQ	Calculated by LHO from CVD prevalence and number of hypertensives. Calculation assumes that people with hypertension are equally likely to have CVD as people without hypertension. Number of hypertensives * (1- CVD prevalence)

4.2 Calculations performed within the tool

The section below describes the calculations made in order to calculate a new life expectancy figure taking into account the effect of the interventions. The methods used for each of the four interventions included in the model are separately presented. The tool assumes that the effect of the four interventions is additive. The methods used to calculate

the effect of the interventions are the same both for the local authority as a whole and for the most deprived quintile.

Methods used to produce a breakdown of the gap, and to calculate all-age all-cause mortality rates are also described below.

4.2.1 Smoking cessation

4.2.1.1 Step 1: Calculate the smokers share of the all cause all age mortality rate

This is calculated by the following formula for each age group:

$$\frac{p_s r_s}{p_s r_s + p_x r_x + 1 - p_s - p_x}$$

p, r – prevalence, risk of all cause mortality relative to never smokers
 s, x – smoker, ex-smoker

Assumptions

- It is assumed that there are no deaths in smokers under the age of 35.

4.2.1.2 Step 2: Calculate the smokers share of the age specific mortality rate

a) Calculate the age specific mortality rate (for all people):

$$\frac{\text{Age specific deaths}}{\text{Age specific population}}$$

b) Calculate the smokers contribution to the age specific mortality rate:

$$\text{Age specific mortality rate} * \text{Smokers share of mortality rate (from step 1)}$$

4.2.1.3 Step 3: Calculate the reduction in age specific all cause mortality rates following smoking cessation

a) Convert 4 week quitters to 52 week quitters

The tool assumes that 29% of people who quit at 4 weeks remain quit at 52 weeks (Bauld L. NHS Stop Smoking Services & Health Inequalities).

b) Calculate the age specific proportion of smokers quitting as a result of smoking cessation

The user input number of smoking quitters is distributed across the age bands according to the age-sex breakdown of smoking quitters in England. Where the England smoking quitter data is only available for broad age bands, for example 60+, the user input number of quitters is additionally apportioned to the 5 year age bands that make up the 60+ broad age group according to the age breakdown of the number of smokers in England.

The age specific proportion of smokers quitting as a result of smoking cessation in the area is then calculated as:

$$\frac{\text{Number of quitters in age group}}{\text{Number of smokers in age group}}$$

c) Calculate the proportional reduction in smokers all cause mortality rates 5 years after quitting

This is the reduction in risk of mortality resulting in becoming an ex-smoker after being a smoker. This is calculated as

$$1 - \frac{\text{Relative risk smokers compared to never-smokers}}{\text{Relative risk ex-smokers compared to never-smokers}}$$

d) Calculate the reduction in age specific all cause mortality rates following smoking cessation:

Smokers share of mortality rate	*	Proportion of smokers quitting as a result of smoking cessation	*	Proportional reduction in smokers all cause mortality rates 5 years after quitting
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Assumptions

- Conversion from 4 week quitters to 52 week quitters applies to all age/sex/geographies.
- The tool assumes that the age breakdown of smoking quitters does not vary by geography.
- It is estimated that stopping smoking will impact on life expectancy in five years time.

4.2.2 Infant mortality

The user input number of infant deaths is used to calculate a new age specific mortality rate for the under 1s

$$\text{Under 1 mortality rate} = \frac{\text{User input number of infant deaths}}{\text{Population under 1}}$$

4.2.3 Antihypertensives

Throughout this section, 'hypertensives' refers to people with undiagnosed hypertension or diagnosed but uncontrolled hypertension, but who do not have diagnosed CHD/stroke.

Steps 1 to 3 are used to estimate the proportion of CHD and stroke mortality which is accounted for by people with undiagnosed hypertension or diagnosed but uncontrolled hypertension, but who do not have diagnosed CHD/stroke.

4.2.3.1 Step 1: Calculate the proportion of stroke/CHD mortality occurring in people with a history of CHD/stroke

A proportion for stroke and CHD separately is calculated.

$$\text{Proportion CHD} = \frac{\text{RR} * \text{Prevalence CHD/stroke}}{(\text{RR} * \text{Prevalence CHD/stroke}) + 1 - \text{Prevalence CHD/stroke}}$$

RR= Relative risk of CHD mortality in those with history of CHD or stroke

$$\text{Proportion Stroke} = \frac{\text{RR} * \text{Prevalence CHD/stroke}}{(\text{RR} * \text{Prevalence CHD/stroke}) + 1 - \text{Prevalence CHD/stroke}}$$

RR= Relative risk of stroke mortality in those with history of CHD or stroke

4.2.3.2 Step 2: Calculate the proportion of stroke/CHD mortality occurring in people with hypertension (undiagnosed or diagnosed but uncontrolled)

A proportion for stroke and CHD separately is calculated.

$$\text{Proportion CHD} = \frac{\text{RR} * \text{Prevalence hypertension}}{(\text{RR} * \text{Prevalence hypertension}) + 1 - \text{Prevalence hypertension}}$$

RR= Relative risk of CHD mortality in hypertensives v normotensives

$$\text{Proportion stroke} = \frac{\text{RR} * \text{Prevalence hypertension}}{(\text{RR} * \text{Prevalence hypertension}) + 1 - \text{Prevalence hypertension}}$$

RR= Relative risk of stroke mortality in hypertensives v normotensives

4.2.3.3 Step 3: Calculate the proportion of CHD/stroke mortality in hypertensives with no previous CHD/stroke

A proportion for stroke and CHD separately is calculated.

$$\text{Proportion (CHD)} = \text{Proportion in hypertensives (step 2)} * (1 - \text{Proportion in people with history of CHD/stroke (step 1)})$$

$$\text{Proportion (stroke)} = \text{Proportion in hypertensives (step 2)} * (1 - \text{Proportion in people with history of CHD/stroke (step 1)})$$

4.2.3.4 Step 4: Calculate the proportion of deaths prevented by hypertensive treatment

A proportion for stroke and CHD separately is calculated. The user input of what number of hypertensives they are going to treat is used in this step.

a) Calculate the proportion of hypertensives to be treated

$$\text{Proportion to be treated} = \frac{\text{Number hypertensives to be treated (entered by user) (all ages)}}{\text{Number of hypertensives (all ages)}}$$

This proportion is then applied to all age groups.

b) Calculate the proportion of deaths prevented by hypertensive treatment

$$\text{Proportion CHD} = \text{Proportion in hypertensives with no previous CHD/stroke (step 3)} * \% \text{ reduction in CHD mortality as a result of treatment} * \text{Proportion of hypertensives to be treated}$$

$$\text{Proportion Stroke} = \text{Proportion in hypertensives with no previous CHD/stroke (step 3)} * \% \text{ reduction in Stroke mortality as a result of treatment} * \text{Proportion of hypertensives to be treated}$$

Assumptions

- The proportion of hypertensives treated is the same in all age groups
- The method assumes that each individual who is treated will experience a 5mmHg fall in their diastolic blood pressure.
- There are no deaths from CHD or stroke in those aged under 45 years.

4.2.3.5 Step 5: Calculate the reduction in age specific all cause mortality rate as a result of hypertensive treatment

a) Calculate age specific mortality rates for CHD and stroke

$$\text{Age specific CHD mortality rate} = \frac{\text{Number of CHD deaths}}{\text{Population}}$$

$$\text{Age specific stroke mortality rate} = \frac{\text{Number of stroke deaths}}{\text{Population}}$$

b) Calculate the reduction in age specific all cause mortality rate as a result of hypertensive treatment

$$\text{Reduction} = (\text{Proportion CHD deaths prevented} * \text{Age spec CHD mortality rate}) + (\text{Proportion stroke deaths prevented} * \text{Age spec stroke mortality rate})$$

4.2.4 Statins

The method for statins is the same as that used for hypertensives. The modelling for statins only considers whether people who have already been selected for hypertensive treatment (in the method above), are also treated with a statin. As in the above section, hypertensives

refers to people with undiagnosed hypertension or diagnosed but uncontrolled hypertension, but who do not have diagnosed CHD/stroke.

4.2.4.1 Step 1: Calculate the proportion of deaths prevented by statin treatment

a) Calculate the percentage reduction in deaths as a result of statin therapy in addition to hypertensive therapy.

The Mant-Hicks method is used to combine the reduction in risk of death as a result of statin treatment combined with antihypertensive treatment. For example, if antihypertensive treatment reduces risk by 10% and statin treatment reduces it by 20%, the combined reduction is not 30% but 28%. The second therapy has only 90% of the original risk to work on and so adds 20% of 90%.

$$\begin{array}{l} \text{\% reduction in deaths due} \\ \text{to statin therapy combined} \\ \text{with hypertensive therapy} \end{array} = 1 - \begin{array}{l} \text{\% reduction in CHD} \\ \text{mortality due to} \\ \text{hypertensive treatment} \end{array} * \begin{array}{l} \text{\% reduction in CHD} \\ \text{mortality due to} \\ \text{statin treatment} \end{array}$$

The same formula is used for stroke.

b) Calculate the proportion of hypertensives to be treated

$$\text{Proportion to be treated} = \frac{\text{Number of hypertensives to be treated (entered by user) (all ages)}}{\text{Number of hypertensives (all ages)}}$$

This proportion is then applied to all age groups.

c) Calculate the proportion of CHD deaths prevented by statin treatment

$$\begin{array}{l} \text{Proportion} \\ \text{CHD deaths} \\ \text{prevented} \end{array} = \begin{array}{l} \text{Proportion in hypertensives} \\ \text{with no previous CHD/} \\ \text{stroke} \\ \text{(step 3 hypertensives)} \end{array} * \begin{array}{l} \text{\% reduction in} \\ \text{CHD mortality as a} \\ \text{result of statin trt} \\ \text{(step 1a above)} \end{array} * \begin{array}{l} \text{Proportion of} \\ \text{hypertensives} \\ \text{to be treated} \end{array}$$

The same formula is used for stroke.

4.2.4.2 Step 2: Calculate the reduction in age specific all cause mortality rate as a result of statin treatment

a) Calculate age specific mortality rates for CHD and stroke

$$\text{Age specific mortality rate} = \frac{\text{Number of CHD deaths}}{\text{Population}}$$

The same formula is used for stroke.

b) Calculate the reduction in age specific all cause mortality rate as a result of statin treatment (after reduction in mortality rates as a result of antihypertensive treatment)

$$\text{Reduction} = (\text{Proportion} * \text{Age spec CHD}) + (\text{Proportion} * \text{Age spec stroke})$$

CHD deaths prevented	mortality rate)	stroke deaths prevented	mortality rate)
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4.2.5 Combining the effect of each intervention and recalculating life expectancy

4.2.5.1 Step 1: Calculate the adjusted age specific all cause mortality rate as a result of the interventions

This is calculated by subtracting the reduction in age specific all cause mortality rates following each intervention (except infant mortality) from the overall age specific all cause mortality rate. For under 1s, instead of subtracting the reduction in under 1s all cause mortality rates for each intervention from the overall under 1 all cause mortality rate, they are subtracted from the adjusted age specific mortality rate following the change in infant mortality.

Assumptions

- The effect of the interventions is additive

4.2.5.2 Step 2: Calculate an adjusted life expectancy following the interventions

The ONS life table is used to calculate life expectancy at birth. This can be downloaded from:

<http://www.statistics.gov.uk/statbase/ssdataset.asp?vlnk=6949&More=Y>

4.2.6 Calculating the impact of the interventions on the life expectancy gap

Different methods are used for the local authority as a whole and for the most deprived quintile. Both are outlined below.

Local authority interventions gap

This is only shown for Spearhead Local Authorities, and refers to the gap in life expectancy between the local authority as a whole and England.

4.2.6.1 Step 1: Recalculate the gap between the local area and England

Calculate the new gap in life expectancy

$$\text{New gap} = \frac{\text{England LE} - \text{Adjusted LA LE}}{\text{England LE}}$$

Assumptions

- That England life expectancy remains constant.
- The model estimates the effect on life expectancy and the life expectancy gap for the selected local authority if the intervention is increased. It shows the effect on the gap if life expectancy in England remains constant, and all other interventions in the local authority have no impact on life expectancy. Therefore it is likely to be an overestimate of the change on the gap as a result of the intervention as in reality interventions will also increase in the rest of England and life expectancy in England will rise, along with a change in other interventions in the local authority.

4.2.6.2 Step 2: Calculate the effect of the interventions on the life expectancy gap

This is the percentage change in the life expectancy gap as a result of the interventions

$$\text{Effect of interventions on gap} = \frac{\text{LE gap before interventions} - \text{LE gap after interventions}}{\text{LE gap before interventions}}$$

Most deprived quintile interventions gap

This is shown for all local authorities, and refers to the gap in life expectancy between the most deprived quintile of the local authority and the life expectancy of the local authority as a whole.

4.2.6.3 Step 1: Recalculate life expectancy in the local authority after intervention in the MDQ

The impact of interventions in the most deprived quintile of the local authority will affect life expectancy in the MDQ and also in the local authority as a whole. This step is to calculate an adjusted life expectancy figure for the local authority as a whole.

a) Calculate the number of lives saved in the most deprived quintile as a result of interventions:

$$\text{Number of lives saved} = \left(\text{Age specific death rate in MDQ} - \text{Adjusted age specific death rate in MDQ} \right) * \text{Population in MDQ}$$

b) Calculate an adjusted number of deaths in the local authority as a whole

$$\text{Adjusted number of deaths in LA} = \text{Number of deaths in LA} - \text{Number of lives saved in MDQ}$$

c) Calculate a new life expectancy in the local authority as a whole using the adjusted number of deaths in the LA

The ONS life table is used to calculate life expectancy at birth. This can be downloaded from:

<http://www.statistics.gov.uk/statbase/ssdataset.asp?vlnk=6949&More=Y>

4.2.6.4 Step 2: Recalculate the gap between the MDQ local authority and the local authority as a whole

Calculate the new gap in life expectancy

$$\text{New gap} = \frac{\text{Adjusted LA LE} - \text{Adjusted MDQ LE}}{\text{Adjusted LA LE}}$$

4.2.6.5 Step 3: Calculate the effect of the interventions on the life expectancy gap

This is the percentage change in the life expectancy gap as a result of the interventions

$$\text{Effect of interventions on gap} = \frac{\text{LE gap before interventions} - \text{LE gap after interventions}}{\text{LE gap before interventions}}$$

4.2.7 All age all cause mortality rates

In addition to providing a figure for the effect of the interventions on the life expectancy gap, the tool also presents the absolute change in all cause all age mortality rates that would be expected to occur as a result of the interventions. The all age all cause mortality rates are modelled from the life expectancy figures before and after the interventions.

4.2.7.1 Step 1: Calculate the all age all cause mortality rates before and after interventions

A different formula is used for males and females. The formula is based on an exponential regression of all age all cause mortality rate on life expectancy, produced by the Department of Health.

$$\text{Male all age all cause mortality rate} = 277174 * e^{-(0.0762 * \text{life expectancy})}$$

$$\text{Female all age all cause mortality rate} = 644553 * e^{-(0.0874 * \text{life expectancy})}$$

4.2.7.2 Step 2: Calculate the absolute change in all age all cause mortality rate

$$\text{Absolute change} = \text{All age all cause mortality rate before interventions} - \text{All age all cause mortality rate after interventions}$$