The economic benefits of reducing health inequalities in England and Wales*

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Abstract

We estimate the economic benefits that might result, if health inequalities in England and Wales were reduced or even eliminated according to a wide range of hypothetical scenarios. Across the board, our estimates in the different scenarios imply an enormous economic benefit associated with improving mortality in the lower socioeconomic groups. In our preferred scenarios, i.e. those which assume that only part of the mortality gradient would be reduced, we find that for the considered adult population as a whole, the economic gains would be on average between about £98 and £118 billion (in 2002 prices). As we leave out parts of the population and ignore any non-fatal conditions or diseases, the estimates are very likely to represent the very lower bound of the true benefits that could result. We do not, however, discuss or factor in the costs and effects of any policies that might help achieve the desired health inequality reduction. Nevertheless, the expected economic benefits of reducing mortality inequalities according to arguably not overly ambitious scenarios appear large and illustrate what is at stake – enough reason to think very hard about how to realise the likely gains, and at what cost.

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1. Introduction

Reducing what appears to be a fairly persistent and often even growing health disadvantage suffered by lower socio-economic groups compared to higher ones has become an important policy objective in many European countries. The rationale for reducing socioeconomic inequalities in health has traditionally been a moral or "social justice" one: health "inequities" were widely seen as unfair in the public health community. In the present paper we explore one part of a potential economic rationale for reducing health inequities, by estimating the hypothetical economic benefits that might result, if health inequalities could be reduced or even eliminated in England and Wales.

This is one of very few studies estimating the economic benefits of reducing health inequalities (or the cost of not doing so). The two most relevant comparator studies are by Mackenbach et al (2007) on the EU-25 countries and Dow and Schoeni (2008) on the US. Mackenbach et al pursued two different approaches in measuring economic costs of health inequalities in one year, 2004: for the EU-25 as a whole the estimates of inequalities-related losses to health as a 'capital good' (leading to less labour productivity) seem to be modest in relative terms (1.4% of GDP) but large in absolute terms (€141 billion). They also valued health as a 'consumption good' – an approach we also follow here in principle and which involves the application of the value of a statistical life (VSL) concept. From this more comprehensive perspective the economic impact of socioeconomic inequalities in health may well be large: in the order of about €1,000 billion, or 9.5% of GDP.[1]

Dow and Schoeni apply the VSL approach to the US. They also find a large potential benefit of improving the health of disadvantaged Americans: raising the health of all Americans to that of college educated Americans would result in annual gains of just over 1 trillion dollars worth of increased health as of 2006.

In this paper we focus (for a start) on inequalities in *mortality*, knowing that these are only part of the overall *health* inequalities that exist between socioeconomic groups. Hence, our resulting estimates on the economic benefits of health inequality reduction will be lower than what they could be, had we captured the full *health* inequalities. The size of socioeconomic inequalities in health depends, among others, on the socioeconomic indicator chosen. Here we propose two different socioeconomic status (SES) variables, one based ultimately on occupational class (NS-SEC) and the second on education. We propose a set of health inequality reductions scenarios for both measures of health inequality and subsequently value the economic benefits of each scenario with respect to the status quo by using the concept of the value of a statistical life.

It is important to note from the outset the single biggest limitation of the Mackenbach et al, Down and Schoeni as well as our own estimates: None of those studies measures the full social costs and benefits of particular policies and programs that could reduce health disparities. No less

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[1] Machenbach et al also separately estimate the impacts on costs of social security and health care systems and health care. Inequalities-related losses to health account for 15% of the costs of social security systems, and for 20% of the costs of health care systems in the European Union as a whole.

importantly, our scenarios are hypothetical. Nevertheless they clearly indicate the (huge) orders of magnitudes that are at stake when considering options that might help reduce health inequalities.

2. Empirical analysis

Any estimation of the economic benefits of reducing socioeconomic inequalities in mortality is bound to start with the accurate description of existing inequalities. This in itself is no small challenge. Fortunately we can build on previous work in this first step of the analysis. As we use two different proxies for socioeconomic status (SES), we will have two sets of “health inequality reduction-scenarios”. The first approach uses the National Statistics Socio-economic Classification (NS-SEC) as SES proxy. The second approach uses educational attainment as the SES proxy.

2.1 Reducing health inequalities by NS-SEC

The NS-SEC is composed of seven analytical classes:

1. Higher managerial and professional;
2. Lower managerial and professional;
3. Intermediate;
4. Small employers and own account workers;
5. Lower supervisory and technical;
6. Semi-routine;
7. Routine.

Full-time students (FTS) are considered separately. A residual category “other” includes never worked, long-term unemployed, inadequately described, and not classifiable for other reasons.[2]

For women, data on socio-economic status are derived from a “combined” approach, i.e. by taking into account not only the woman’s own occupation but also the husband’s NS-SEC class, where available. We use age-specific mortality rates in 5-year age groups (30-34, 35-39, …, 50-54, 55-59). Age-specific mortality rates for NS-SEC classes, using the combined classification for women aged 30-59, referring to the years 2001-2003, are taken from “Health Statistics Quarterly 42 Summer 2009” (available at www.statistics.gov.uk/downloads/theme_health/HSQ42.pdf). Similarly, age-specific mortality rates for NS-SEC classes for men aged 30-59 are obtained from “Health Statistics Quarterly 36 Winter 2007” (available on-line at www.statistics.gov.uk/downloads/theme_health/HSQ36.pdf). As for men, NS-SEC is composed of eight classes, as the first class has been disaggregated into two subclasses (1.1 – large employers, higher managers and 1.2 – higher professionals). We merge two classes in order to increase

2 For details about the NS-SEC, see NS-SEC User Manual, Office for National Statistics (Office for National Statistics (2002) *The National Statistics Socio-Economic Classification User Manual*: Version no. 1, The Stationery Office: London).

comparability of the numbers between genders (age-specific mortality rates are estimated from deaths and person years at risk for the two NS-SEC classes).

Age-specific mortality data for full-time students and the category "other" are not available for men. We estimate mortality rates for both categories starting from deaths and person years at risk. For men, only the denominator (person years at risk) is available for all age groups, while information on deaths refers to the death registrations 2001-2003 by NS-SEC for men aged 30-64. Estimates of male deaths of full-time students for the 5-year age groups are generated in two steps. First, we calculate the percentage of deaths at age 30-59, considering the distribution of deaths for the seven NS-SEC classes (among men). Second, we estimate the deaths in the 5-year age groups following the same distribution observed among deaths of female students. A similar approach is used for the category "other".

Health inequality reduction scenarios based on NS-SEC as SES proxy

Having calculated age-specific mortality rates by NS-SEC classes (and for full-time students as well as "others"), the next step involves multiplying these mortality rates by the population at risk by NS-SEC classes and 5-year age groups with reference to the years 2001-2003 (data for women are available from the above cited "Health Statistics Quarterly 42 Summer 2009", and for men from "Health Statistics Quarterly 36 Winter 2007"): in both cases we refer to optimised population estimates, which are adjusted for 2001 Census "Filter X" rule and health selection. In this way, we obtain the estimated number of deaths, by age groups and NS-SEC (Table 1).

Table 1. *Estimated number of death by NS-SEC class, persons aged 30-59 in 2003.*

	REAL DATA – MEN by NS-SEC									
	1	2	3	4	5	6	7	FTS	Others	total
30-34	379	625	343	555	570	816	1,162	65	839	5,354
35-39	551	967	313	861	806	1,065	1,532	47	1,143	7,284
40-44	886	1,618	295	1,186	1,193	1,489	2,001	28	1,304	9,999
45-49	1,379	2,234	608	1,995	1,871	1,917	2,970	28	1,701	14,704
50-54	2,208	3,732	1,034	3,342	3,096	3,037	4,848	10	2,134	23,442
55-59	3,149	5,734	1,298	5,405	5,039	4,736	7,460	9	2,720	35,550
Total	8,551	14,910	3,892	13,343	12,574	13,060	19,974	187	9,841	96,332
	REAL DATA – WOMEN by NS-SEC									
	1	2	3	4	5	6	7	FTS	Others	total
30-34	287	629	434	177	222	570	359	46	298	3,016
35-39	505	1,044	607	311	397	803	533	33	406	4,639
40-44	776	1,513	871	524	572	1,191	829	20	463	6,760
45-49	1,137	2,301	1,192	836	972	1,749	1,209	20	604	10,026
50-54	1,704	3,953	1,926	1,489	1,613	2,672	1,965	7	758	16,087
55-59	2,378	5,159	2,608	2,347	2,648	3,861	3,051	6	966	23,023
Total	6,786	14,599	7,638	5,684	6,424	10,847	7,946	132	3,495	63,551

Subsequently, we simulate the number of life-years that would be gained if people of lower NS-SEC classes experienced the lower mortality rates of those of higher NS-SEC classes. (See Annex Tables 1 and 2 for the baseline age-specific mortality rates by NS-SEC for men and women.)

In particular, we considered six different scenarios:

1. "others" and 7th NS-SEC class decrease their mortality rates to those of the 6th NS-SEC class;
2. mortality rates of the 6th and 7th NS-SEC class and of "others" decrease to those of the 5th NS-SEC class;
3. mortality rates of the 5th, 6th, 7th NS-SEC class and of "others" decrease to those of the 4th NS-SEC class.
4. mortality rates of all classes (from the 2nd to the 7th NS-SEC class), of "others" and of FTS decrease to those of the 1st NS-SEC class.
5. Mortality rates of all classes (from the 2nd to the 7th NS-SEC class), of "others" and of male FTS[3] decrease by half the differences by the mortality rate of the 1st NS-SEC class and those of the others.
6. Mortality rates of all classes (from 2nd to the 7th NC-SEC class), of "others" and of male FTS decrease by half the gradient of mortality rates with respect to NS-SEC class and those of others. In practice, for each age range the coefficients a and b of a regression line between y (mortality rates) and x (NC-SEC class) have been estimated and the new scenario is obtained by $\tilde{y} = \hat{a} + \frac{b}{2}x$, i.e. The estimated slope coefficient is diminished by half.

By comparing the number of deaths simulated in the different scenarios to the number of deaths in the initial situation, we can derive the number of premature deaths prevented in each scenario. These estimates are reported in Table 2. Evidently, scenarios 1 to 4 follow a successively more ambitious order, with scenario 4 as by far the most ambitious one, in which all classes reach the low mortality rates of the highest NS-SEC class. Scenarios 5 and 6 are more modest, but perhaps more plausible again, in that they assume that there will be *some* convergence in class-specific mortality rates, and hence a decrease, but no elimination of the mortality gradient.

[3] Mortality rates of female full-time students are unchanged since their levels are lower than mortality rates of the 1st NS-SEC class.

Table 2. *Estimated number of individuals whose premature deaths would be prevented under alternative scenarios, persons aged 30-59 in 2003*.

	PREMATURE DEATHS PREVENTED – MEN					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
	Others + 7th class reach 6th class' morality rates (Others+7th≡6th)	Others + 7th + 6th ≡ 5th	Others + 7th + 6th + 5th ≡ 4th	Others + 7th + 6th + 5th + 4th + 3th + 2nd ≡ 1st	Halve MR difference between 1st and each of the lower classes	Halve the gradient
30-34	768	1,755	916	3,216	1,608	1,754
35-39	1,034	2,213	1,970	4,260	2,130	2,247
40-44	1,089	2,559	2,943	5,018	2,509	2,291
45-49	1,757	3,059	3,603	7,097	3,549	3,356
50-54	2,222	3,894	5,573	10,542	5,271	4,586
55-59	2,492	4,311	7,915	16,292	8,146	7,524
Total	9,363	17,791	22,920	46,426	23,213	21,758
	PREMATURE DEATHS PREVENTED – WOMEN					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
30-34	213	456	529	1,391	685	733
35-39	350	519	891	1,937	966	1,006
40-44	461	890	1,190	2,534	1,273	1,058
45-49	579	1,001	1,844	3,579	1,795	1,276
50-54	884	1,079	2,562	5,421	2,718	2,232
55-59	1,308	309	2,736	5,323	2,673	1,441
Total	3,795	4,253	9,752	20,185	10,111	7,746

* a negative number indicates that the number of deaths under that scenario is higher than that observed in real data.

We then have to take into account the fact that those individuals whose premature deaths would have been prevented in 2003 would be expected to live many more years beyond 2003, on average. To do so, we need information on life expectancies by 5-years age groups for each of the NS-SEC classes (and for full time students and "others"). The total number of life years saved with improved mortality is equal to the number of premature deaths prevented in 2003 multiplied by remaining life expectancy, for each age group and NS-SEC class. Table 3 reports these data. A necessary intermediate step consists of estimating life expectancies by 5-years age groups for each category of the NS-SEC classes. Unfortunately, complete life tables for NS-SEC are not available, so that life expectancies should be estimated. Our estimates are derived from the application of the Brass model[4] (Brass et al., 1968; Brass, 1971)[5], using the death probabilities by educational level (see below) as a reference.

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[4] The Brass model relies on choosing a standard life table and generating other life tables by the following formula:

$$\text{logit}\left(l_x^P\right) = a + b \cdot \text{logit}\left(l_x^S\right)$$

where P refers to the new population and S to a standard one, and "logit" is defined as follows:

$$\text{logit}(y) = 0.5 \cdot \log_e\left[(1 - y)/y\right].$$

New tables (represented by l_x^P in the formula) are generated by varying a and b. In this paper, standard life tables are those by educational level.

[5] Brass W., Coale A.J., Demeny P., Heisel D.F., Lorimer F., Romaniuk A., van de Walle E. (1968). The Demography of Tropical Africa. Princeton, N.J.: Princeton University Press. Brass W. (1971). On the scale of mortality. In Brass W. (ed.). Biological Aspects of Demography. London: Taylor and Francis.

Table 3. *Total number of life years saved under alternative scenarios, persons aged 30-59 in 2003*
* a negative number indicates that the number of deaths under that scenario is higher than that observed in real data.

SAVED LIFE YEARS – MEN						
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
	Others + 7th class reach 6th class' morality rates (Others+7th≡6th)	Others + 7th + 6th ≡ 5th	Others + 7th + 6th + 5th ≡ 4th	Others + 7th + 6th + 5th + 4th + 3th + 2nd ≡ 1st	Halve MR difference between 1st and each of the lower classes	Halve the gradient
30-34	34,285	82,840	44,720	162,525	74,375	87,206
35-39	41,046	93,455	86,398	194,016	87,911	100,420
40-44	37,849	95,340	114,504	203,549	91,529	90,747
45-49	52,514	98,948	122,448	252,770	113,177	116,792
50-54	55,788	107,052	162,372	323,683	145,026	137,463
55-59	51,027	98,001	192,904	421,147	188,861	191,424
Total	272,508	575,637	723,346	1,557,691	700,879	724,053
	SAVED LIFE YEARS – WOMEN					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
30-34	10,311	21,932	26,737	73,858	34,775	36,494
35-39	15,201	22,376	40,571	93,134	44,173	45,063
40-44	17,734	33,975	48,260	109,257	51,867	41,885
45-49	19,441	33,273	65,688	136,534	64,158	43,706
50-54	25,391	30,629	78,709	180,138	84,298	67,183
55-59	31,324	7,279	70,851	150,888	68,930	34,159
Total	119,401	149,463	330,817	743,809	348,200	268,489

2.2 Reducing health inequalities by education

A similar approach can be followed using education as the SES proxy. Population by education and 5-year age group (and sex) is obtained from the one per cent sample of the Census in England and Wales. In addition, crude mortality rates by education and age group (and sex) are available. Educational level is categorized into four groups:

1 - No information;

2 - Highest qualification is A level;

3 - Highest qualification is sub-degree level but higher than A level;

4 - Highest qualification is ordinary degree or higher degree level.

The category "no information" includes almost 83% of the population and it combines those with no qualifications (80% of the population) with those for which education is "not stated" (below 3% of the population). Both represent "disadvantaged" groups and are characterised by comparatively high mortality and illness rates.

Data are available for individuals aged 30 and older,[6] allowing us to directly obtain life-expectancies according to education: mortality rates are used to estimate age-specific mortality probabilities and starting from these a life table (and consequently life expectancies) can be obtained. We obtain the number of deaths by multiplying age-specific mortality rates for education groups by the population at risk (Table 4). (See Annex Tables 3 and 4 for the baseline age-specific mortality rates by education for men and women.)

Table 4. *Estimated number of death by education, persons aged 30 and older.*

REAL DATA – MEN					
	No information	A level	Sub-degree but higher than A	Ordinary degree or higher degree	Total
30-34	1,788	0	58	141	1,987
35-39	2,115	116	128	163	2,522
40-44	3,453	221	220	479	4,373
45-49	5,252	269	386	374	6,280
50-54	8,692	305	742	519	10,258
55-59	14,057	604	840	1,051	16,552
60-64	23,570	946	850	916	26,283
65-69	37,541	1,432	1,382	1,589	41,945
70-74	46,527	2,015	1,743	1,857	52,141
75-79	56,083	1,951	1,943	2,744	62,722
80-84	48,404	1,535	1,346	1,946	53,230
85-89	27,552	424	433	1,606	30,016
Total	275,034	9,818	10,072	13,383	308,307

[6] Data on deaths by educational status in England and Wales has kindly been made available from the Eurothine project, an EU-wide effort to produce data on socioeconomic inequalities in health, see http://survey.erasmusmc.nl/eurothine/ (last accessed 10/12/2009).

REAL DATA – WOMEN					
	No information	A level	Sub-degree but higher than A	Ordinary degree or higher degree	Total
30-34	1,112	0	70	82	1,263
35-39	1,542	140	81	128	1,890
40-44	2,811	69	174	210	3,264
45-49	3,629	163	338	175	4,305
50-54	4,877	117	374	93	5,460
55-59	8,265	324	551	117	9,258
60-64	16,296	374	754	117	17,541
65-69	27,194	707	927	166	28,994
70-74	38,640	798	1,411	346	41,196
75-79	59,482	995	2,649	547	63,673
80-84	66,598	1,296	2,833	693	71,421
85-89	63,077	694	2,529	482	66,782
Total	293,523	5,677	12,692	3,155	315,047

Health inequality reduction scenarios based on education as SES proxy

Following in principle the approach used above, we can simulate the number of life-years that would be gained if people of lower educational groups experienced the lower mortality rates of those of higher educational levels. Five different scenarios are considered:

1. Mortality level of people with “no information” decreases to that of the people with “A level”;
2. People with “no information” or with A level decrease their mortality level to that of the people with sub-degree educational level;
3. Mortality level of all education groups is the same of that of degree level;
4. Mortality level of all education group decreases by half the differences between the mortality rate of degree level and those of the others.
5. Mortality level of all education group decreases by half the gradient between the mortality rate of degree level and those of the others. Formally, for each age range the coefficients a and b of a regression line between y (mortality rates) and x (education level) have been estimated and the new scenario is obtained by $\tilde{y} = \hat{a} + \frac{b}{2}x$, i.e. the estimated slope coefficient is diminished by half.

By comparing the number of deaths simulated in the different scenarios to the number of deaths in the status quo situation, we can derive the premature deaths that would be prevented in the different scenarios. The estimates of the individuals whose premature deaths would be prevented under alternative scenarios are reported in Table 5.

It should be noted that scenarios 1, 4, and 5 produce the highest gains in life-years. This is due to the high imbalance of the distribution of individuals across different educational levels: 80% of the population falls into the “no information” group. Therefore, the scenarios that change the death rates for this group will have a substantial effect on the number of life years saved.

Table 5. *Estimated number of individuals whose premature deaths would be prevented under alternative scenarios, persons aged 30 and older*.

	PREMATURE DEATHS PREVENTED - MEN				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	No information ≡ A-level	No information + A-level ≡ sub-degree level	No information + A-level + sub-degree level ≡ degree level	Halve MR difference between degree level and each of the lower classes	Halve the gradient
30-34	1,788	1,105	932	466	995
35-39	-258*	947	1,331	666	564
40-44	643	1,590	766	383	212
45-49	1,195	1,982	3,002	1,501	1,516
50-54	3,717	317	4,635	2,317	3,097
55-59	3,572	3,729	4,544	2,272	2,393
60-64	5,662	11,274	13,832	6,916	6,666
65-69	2,742	12,895	16,597	8,298	7,598
70-74	-1,421*	9,657	16,653	8,326	7,646
75-79	-901*	7,674	14,950	7,475	7,056
80-84	-3,167*	12,235	16,766	8,383	7,003
85-89	6,368	10,038	5,226	2,613	2,210
Total	19,940	73,443	99,235	49,617	46,395

* a negative number indicates that the number of deaths under that scenario is higher than that observed in real data.

	PREMATURE DEATHS PREVENTED – WOMEN				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	No information ≡ A-level	No information + A-level ≡ sub-degree level	No information + A-level + sub-degree level ≡ degree level	Halve MR difference between degree level and each of the lower classes	Halve the gradient
30-34	1,112	371	373	187	317
35-39	-1,077*	986	322	161	-142*
40-44	1,659	1,342	118	59	13
45-49	137	641	537	269	202
50-54	1,358	1,102	2,588	1,294	1,476
55-59	-837	2,314	4,860	2,430	2,265
60-64	4,108	5,248	12,081	6,040	6,546
65-69	1,329	10,667	17,337	8,669	8,185
70-74	9,256	7,742	9,315	4,658	5,243
75-79	13,056	4,385	9,558	4,779	6,512
80-84	-3,097*	3,939	15,711	7,855	7,767
85-89	378	-3,828*	29,902	14,951	17,515
Total	27,383	34,910	102,703	51,351	55,897

* a negative number indicates that the number of deaths under that scenario is higher than that observed in real data.

Taking into account that those individuals, whose premature deaths were prevented, would be expected to live many more years, on average, and taking into account life expectancies by 5-years age groups for each of the education groups, Table 6 presents the estimated total number of life years saved with improved mortality.

Table 6. *Total number of life years saved under alternative scenarios, persons aged 30 and older*
* a negative number indicates that the number of deaths under that scenario is higher than that observed in real data.

	SAVED LIFE YEARS - MEN				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	No information ≡ A-level	No information + A-level ≡ sub-degree level	No information + A-level + sub-degree level ≡ degree level	Halve MR difference between degree level and each of the lower classes	Halve the gradient
30-34	79,272	50,950	44,196	21,018	46,460
35-39	-10,133*	38,955	56,518	26,792	23,532
40-44	22,115	57,469	28,717	13,433	7,689
45-49	35,230	61,865	97,743	45,624	48,250
50-54	91,612	8,345	128,306	59,354	83,406
55-59	71,174	80,767	104,070	47,339	53,228
60-64	87,324	193,630	253,458	113,397	118,042
65-69	30,914	166,917	231,640	101,856	101,953
70-74	-11,049*	88,853	166,992	72,451	73,399
75-79	-4,683	47,944	101,644	43,956	45,948
80-84	-11,428*	52,515	75,979	33,487	30,765
85-89	18,400	31,729	16,359	7,649	6,901
Total	398,748	879,938	1305,621	586,356	639,784

* a negative number indicates that the number of deaths under that scenario is higher than that observed in real data.

	SAVED LIFE YEARS – WOMEN				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	No information ≡ A-level	No information + A-level ≡ sub-degree level	No information + A-level + sub-degree level ≡ degree level	Halve MR difference between degree level and each of the lower classes	Halve the gradient
30-34	54,081	18,379	19,210	9,230	16330
35-39	-47,006*	43,934	14,946	7,136	-6615*
40-44	64,212	53,119	4,880	2,234	530
45-49	4,631	22,201	19,651	9,291	7372
50-54	39,226	32,773	82,022	38,526	46764
55-59	-20,161*	57,638	130,608	60,736	60865
60-64	79,997	106,025	267,300	122,652	144839
65-69	20,030	167,535	302,935	137,115	143013
70-74	102,714	89,003	121,183	54,177	68202
75-79	99,437	34,351	87,000	38,527	59270
80-84	-15,034*	19,899	95,187	41,937	47057
85-89	1,210	-12,615*	118,763	53,100	65564
Total	383,337	632,243	1263,685	574,661	657223

3. Monetary valuation of the life years gained in the different scenarios

The final step ascribes a monetary value to the additional life-years gained. Assigning monetary values to life and health is a highly controversial topic in health (but much less in economics). Hence we start by motivating and explaining the basic approach adopted.

Much of the reservation about putting a monetary value on life and health stems from a misunderstanding of what such a value actually means. In fact, we cannot – and do not seek to – place a monetary value on our own or others' lives. Instead, we are valuing often comparatively small changes in the risk of mortality, a very different matter. A more appropriate term than value of life would thus be the value of mortality risk reduction. While under normal circumstances no one would trade his or her life for money, most people would weigh safety against cost in choosing safety equipment, safety against time in crossing a street, and on-the-job risks against different wages. In making these choices, people are implicitly putting a price on their risk of mortality.

While the value of a reduction in mortality risk is not directly observable, it can be inferred from the decisions people make when choosing between mortality risk and financial compensation. The most common procedure uses labour market data about the wage premium workers demand from a job with higher mortality risk, as it is well known that, given a choice, individuals demand higher wages to work in jobs associated with greater risks, such as coal mining or off-shore oil work. For example if an individual is willing to forego €200 to reduce the risk of mortality by 1/1000, this trade-off gives a value of life of €200,000 only in the sense that the risk reduction is achieved in a population of 1000: if mortality risk is reduced by 1/1000 per capita over a population of 1000, this is the same as saying that we expect – statistically – one life to be saved in this population. Put this way, we can also speak of the "value of a statistical life" (VSL).

Yet is it really possible to elicit an actual price to be placed on life or health? It would be foolish to pretend that this is easy. Nevertheless, there is now a wealth of studies that have measured how people value the risks of mortality or even morbidity. Many of these studies infer willingness to pay for small changes in mortality risk from observed choices in labour markets and in markets for safety-related products (e.g., seat belts, smoke detectors). Other studies use what is termed contingent valuation methodology, where people are asked directly what they would be willing to pay for a change in risk, using surveys. The considerable experience that has accumulated with both market-based and survey approaches has led to significant improvements in the methods used but there is still a sizeable variation in the estimates obtained from different studies, as well as large confidence intervals around the point estimates obtained from any single willingness-to-pay study.

While this is a challenge that calls for cautious use of such estimates (as well as for the use of appropriate sensitivity analyses), it is certainly not a reason for abandoning the pursuit of more accurate measures of this meaningful concept. Further improvement in both measurement methods and data sources will make it possible to narrow the degree of uncertainty around estimates. Indeed, the act of undertaking such measurements has value in itself as it forces decision makers to be explicit about what are often implicit and unexamined choices concealed within policy decisions.

There is a host of estimates of the VSL in the literature, including a growing number based on European labour market data. For example, one recent study, using surveys from France, Italy and the UK, estimated a VSL range of €1.052 to €2.258 million, with a life year valued between €55,000 and €142,000. These estimates are comparable to those from a 2006 study of German labour market data, which estimated the VSL at €1.9 million to €3.5 million, depending on the method of calculation. These estimates are not too dissimilar from values that have been proposed and are being used in the UK. A seemingly well established VSL estimate has been derived by the Department for Transport: £1.25 million (in 2002 prices), based on 2002 road traffic data. This value has been used, typically with a range of +/- 25% around its central value, by the Home Office, HSE, Environment Agency, Food Standards Agency and other government bodies.[7] For the purpose of our present exercise we also employ this figure.

With a number of simplifying assumptions[8], it is possible to convert the VSL value into a Value of a Statistical Life *Year* (VoSLY) using the standard compound interest formulae $VoSLY = VoSL/d * [1-(1+d)^{-L}]$ with L as the remaining years up to life expectancy, and d as the discount rate.

Assuming the Value of a Statistical Life is for an 'average' person, aged, say, 40 years, and a remaining life expectancy of 40 years (=L), and also assuming the recommended discount rate of 3.5% (=d), the VoSLY for the UK would be about £58,000.[9] To express future amounts in present value terms (Dow and Schoeni, 2008)[10], a discount rate of 3.5% is used.

Table 7 shows the benefits associated with improved mortality in different scenarios considering the NS-SEC classification.

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7 See HM Treasury (2005). Managing Risks to the Public: Appraisal Guidance. For the specific road safety values, and how to up-rate them annually, see the typically annual Department for Transport's Highways Economics Notes, available at: http://www.dft.gov.uk/pgr/roadsafety/ea/ (last accessed 10/12/2009).

8 In addition to the critical assumption that each year of life over the life cycle has the same value, this approach assumes that the VSL can be expressed as the present discounted value of these annual amounts. In practice, a number of factors are likely to lead to differences in how one values survival at different ages, e.g. changes in wealth levels, family responsibilities, health status, and other aspects of one's life cycle. For a critical discussion see e.g. Hammitt, 2007 J.K. Hammitt, Valuing changes in mortality risk: lives saved vs. life years saved, Review of Environmental Economics and Policy 1 (2007), pp. 228–240.

9 We also allow for a range of VoSLY estimates in our sensitivity analysis, assuming +/-25% of the mean value (i.e. £43,500 and £72,500).

10 Dow W., Schoeni R. F. (2008). Economic Value of Improving the Health of Disadvantaged Americans. Technical Report for Overcoming Obstacles to Health: Report from the Robert Wood Johnson Foundation to the Commission to Build a Healthier America.

Table 7. *Expected benefits (in* **billion £)** *associated with improved mortality under alternative scenarios, NS-SEC classification, persons aged 30-59.*

	MEN					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
	Others + 7th class reach 6th class' morality rates (Others+7th≡6th)	Others + 7th + 6th ≡ 5th	Others + 7th + 6th + 5th ≡ 4th	Others + 7th + 6th + 5th + 4th + 3th + 2nd ≡ 1st	Halve MR difference between degree level and each of the lower classes	Halve the gradient
Valuation for each life year:					76.8	62.0
£58,000	29.0	65.9	79.9	179.7		
25% less	21.7	49.4	59.9	134.8	57.6	47.14
25% more	36.2	82.4	99.8	224.6	96.0	78.6
	WOMEN					
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6
Valuation for each life year:					40.8	38.6
58,000	13.2	17.9	38.1	93.3		
25% less	9.9	13.5	28.6	70.0	30.6	28.9
25% more	16.5	22.4	47.7	116.6	51.0	48.2

* a negative number indicates that the number of deaths under that scenario is higher than that observed in real data.

A similar approach can be followed using the other measure of advantage/disadvantage (education); Table 8 reports the benefits associated with improved mortality in different scenarios based on educational health inequalities.

Table 8. *Expected benefits (in billion £) associated with improved mortality under alternative scenarios, education classification, persons aged 30 and older.*

	MEN				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	No information ≡ A-level	No information + A-level ≡ sub-degree level	No information + A-level + sub-degree level ≡ degree level	Halve MR difference between degree level and each of the lower classes	Halve the gradient
Valuation for each life year:					
£58,000	38.5	78.0	113.5	49.6	57.0
25% less	28.9	58.5	85.2	37.2	42.7
25% more	48.2	97.5	141.9	62.0	71.2

	WOMEN				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	No information ≡ A-level	No information + A-level ≡ sub-degree level	No information + A-level + sub-degree level ≡ degree level	Halve MR difference between degree level and each of the lower classes	Halve the gradient
Valuation for each life year:					
£58,000	34.2	58.1	108.3	47.8	53.0
25% less	25.6	43.5	81.3	35.8	39.8
25% more	42.7	72.6	135.4	59.7	66.3

4. Discussion

Across the board, our estimates in the different scenarios imply an enormous economic benefit associated with improving mortality in the lower socioeconomic groups. While it is beyond the scope of this paper to determine the "correct" scenario out of the many we presented, we tend to prefer the last two scenarios for both the NS-SEC based estimates and the education based ones. In either case the idea is that only part of the difference in mortality rates between the highest class and any of the lower ones will be reduced. If we assume this was a realistic objective, we find a remarkably close match in the estimates across both the NS-SEC and the education based scenarios: For the considered adult population as a whole, the gains would be expected to lie on average at about £98 to £118 billion (in 2002 prices). In the most ambitious scenario, where we assume an equalisation of all mortality rates to the level of the highest socioeconomic class, the economic benefits would total about £222 billion on the basis of the education data and £273 billion on the basis of the NS-SEC data.

While it is hard to put these numbers into perspective, one way of doing so is by comparing them to the levels of total Gross Value Added (GVA) for England in 2002, which was £805.5 billion[11] in current prices. Expressed as a percentage of GVA, the health gains in the more modest scenarios of reducing (but not eliminating) the mortality gaps, would correspond to about 12-15% of GVA.

Bearing in mind that we leave out parts of the population and focus only on mortality, ignoring any non-fatal conditions or diseases, the estimates are very likely to represent the very lower bound of the true benefits that might result. The estimates do not include disparities in mortality by NS-SEC classes among people over 60. On the other hand, the scenarios based on educational health inequalities consider people beyond 60 but exclude people less than 30 years of age,

We obviously used two different classifications of socio-economic status of individuals, one based on education and the other based ultimately on occupation. We are not in a position to judge whether any of the two is superior to the other, since both have different advantages and drawbacks. The education-based one has the advantage that it comes with an estimate of death rates for all ages over 30. This allows calculating life expectancies without using interpolations that have been used for the occupational-based classification. However, the fact that more than 80% of the population is concentrated in one educational category does render this classification less informative than it could be. The classification based on occupational categories is much more refined.

In closing we can only re-emphasise that the numbers presented should not be interpreted as the full social costs and benefits of particular policies and programs that could reduce health disparities. That said, the expected economic benefits of reducing mortality inequalities according to (arguably) not overly ambitious scenarios appear large and illustrate what is at stake – enough reason to very seriously consider how realise the likely gains.

[11] GVA time series for regional data are available here http://www.statistics.gov.uk/statbase/Prep/14650.asp (last accessed 10/12/2009)

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Annex

Annex Table 1: Age-specific mortality rates by NS-SEC combined classification, men aged 30-59, 2001-2003 (RATE PER 100,000)

	Class								
Age	1	2	3	4	5	6	7	full time students*	Others*
30–34	36	45	80	98	65	125	140	435	521
35–39	49	70	89	104	94	167	181	780	822
40–44	88	128	99	138	155	257	266	946	1196
45–49	152	200	242	252	280	383	439	567	2025
50–54	253	324	396	387	473	603	676	331	2924
55–59	403	567	564	634	823	965	1004	851	5037

Annex Table 2: Age-specific mortality rates by NS-SEC combined classidication, women aged 25-59, 2001-2003 (RATE PER 100,000)

	Class								
Age	1	2	3	4	5	6	7	full time students*	Others*
30–34	27	35	49	50	54	71	84	48	151
35–39	43	56	71	67	87	99	126	52	236
40–44	74	88	114	112	130	165	226	45	338
45–49	127	147	175	185	243	283	379	80	516
50–54	205	258	266	282	376	393	549	64	689
55–59	363	392	371	462	606	526	757	75	863

Annex Table 3: Age-specific mortality rates by education, MEN aged 30-90, RATE PER 100,000

MEN	No information	A level	Sub-degree but higher than A	Ordinary degree or higher degree
30-34	117	0	45	55
35-39	160	180	93	67
40-44	249	202	139	189
45-49	427	330	270	200
50-54	752	430	707	383
55-59	1271	948	935	870
60-64	2159	1640	1152	943
65-69	3661	3393	2442	2113
70-74	5888	6068	4722	3909
75-79	9366	9516	8132	7001
80-84	14124	15048	10684	9444
85-89	21211	16308	13539	17085

Annex Table 4: Age-specific mortality rates by education, WOMEN aged 30-90, RATE PER 100,000

WOMEN	No information	A level	Sub-degree but higher than A	Ordinary degree or higher degree
30-34	69	0	46	46
35-39	111	189	48	88
40-44	181	74	93	160
45-49	270	260	224	231
50-54	398	288	308	201
55-59	696	767	511	320
60-64	1314	983	894	392
65-69	2124	2020	1310	829
70-74	3500	2661	2795	2662
75-79	5903	4608	5450	4970
80-84	9602	10048	9052	7457
85-89	16228	16131	17201	8927