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Title:

Relative compression or expansion of morbidity: further evidence from the Global Burden of Disease Study 2010

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Abstract

Healthy life expectancies (HALE) for 187 countries in 1990 and 2010 were produced as part of the Global Burden of Disease Study 2010 (GBD 2010). Salomon et al (2012) examined absolute changes in years of life lost to disability and found evidence for the expansion of morbidity. This article examines the evidence for compression or expansion of morbidity on a relative basis compared to the absolute approach presented in Salomon et al.

In spite of the higher number of cases of relative compression, the different levels of change between those countries with relative compression and those with relative expansion means that at a global level the conclusion that there has been not only absolute but also relative expansion of morbidity is confirmed.

Keywords

Background

An important output of the Global Burden of Disease Study (GBD) 2010 was the calculation of healthy life expectancy (HALE) for 187 countries at two points in time, 1990 and 2010 [1]. The methods used were rigorous and consistent, making this a particularly rich source for analysis of changes in morbidity by country, age, sex and over time. In particular Salomon and his co-authors explored the evidence provided for either of the competing hypotheses of expansion or compression of morbidity. Their conclusion was that "*As life expectancy* [LE] *has increased, the number of healthy years lost to disability has also increased in most countries, consistent with the expansion of morbidity hypothesis*" (ibid, p 2144) and they further make a cogent argument for use of healthy life expectancy as an indicator of population health, in particular at the global level. In reaching this conclusion they chose to focus on absolute rather than relative measures of the change in morbidity, noting that "*such an analysis* [ie based on relative rather than absolute measures] *yields a similar general conclusion…(data not shown)*" (ibid, p 2158).

Salomon et al [1] provide an effective introduction to the concept of HALE and the use of Sullivan's method for its calculation as well as to the three generally accepted hypotheses of possible future change – expansion of morbidity, compression of morbidity or dynamic equilibrium (see [2] for further detail).

HALE increased more slowly than LE over the period 1990 to 2010. Salomon et al's interpretation is that expansion of morbidity is occurring since the absolute number of years lost to disability (ie YLD which is defined as LE minus HALE) is increasing.

Indeed they state "*the world's population loses more years of healthy life to disability than it did 20 years ago*" (ibid, p 2147).

I was interested to further explore the evidence for expansion or compression of morbidity, particularly from a relative rather than an absolute perspective, since it could not be reported in Salomon et al's original work. An absolute increase in global healthy life expectancy is a positive outcome for global public health and the proportions of the human lifespan spent in good or poor health are also meaningful. Salomon et al acknowledge that to observe an absolute compression of morbidity would require HALE to increase more than LE, leading to a drop in YLD. This is clearly a worthwhile public health goal, but if we observe that the proportion of the lifespan spent in good health is increasing we should acknowledge this as a partial success on the way to a perhaps utopian goal of long life spent entirely in good health.

In this article, the data, which is freely available [3], is further analysed from the perspective of relative measures of the change in morbidity. It examines how the patterns of relative measures differ from those of absolute measures. Exploring the data using relative measures produces additional insights to those in Salomon et al.

Methods

The dataset of Healthy Life Expectancy by Country 1990-2010 was downloaded [3] as a CSV file and manipulated in MS Excel. This dataset contains the following numerical items:

le   Life Expectancy (LE)

hale   Healthy Life Expectancy (HALE)

For each combination of:

Country code (ISO3) / Country name (187 instances)

Year (2 instances – either 1990 or 2010)

Age range (18 classes, 0-1, 1-4, and 5 year age bands until 80+)

Sex (Male or Female)

Thus for each measure, LE and HALE, there are 187 x 2 x 18 x 2 = 13,464 data points. Confidence intervals are also provided but are not used in this analysis. I added the following columns to the dataset, for each data point:

le – hale   Healthy years lost to disability (YLD)

(le-hale)/le   YLD as a proportion of LE

From this I was able to classify each of the 6,732 combinations of country, sex and age range regarding the change from 1990 to 2010 in two ways:

(1) either Absolute Expansion or Absolute Compression of morbidity and

(2) either Relative Expansion or Relative Compression of morbidity

These cases arise for any given combination of country, sex and age band as defined in Table 1 and exemplified in Table 2.

Table 1 - Definitions for classification as a case of expansion or compression of morbidity, on an absolute and relative basis, following Howse [2]

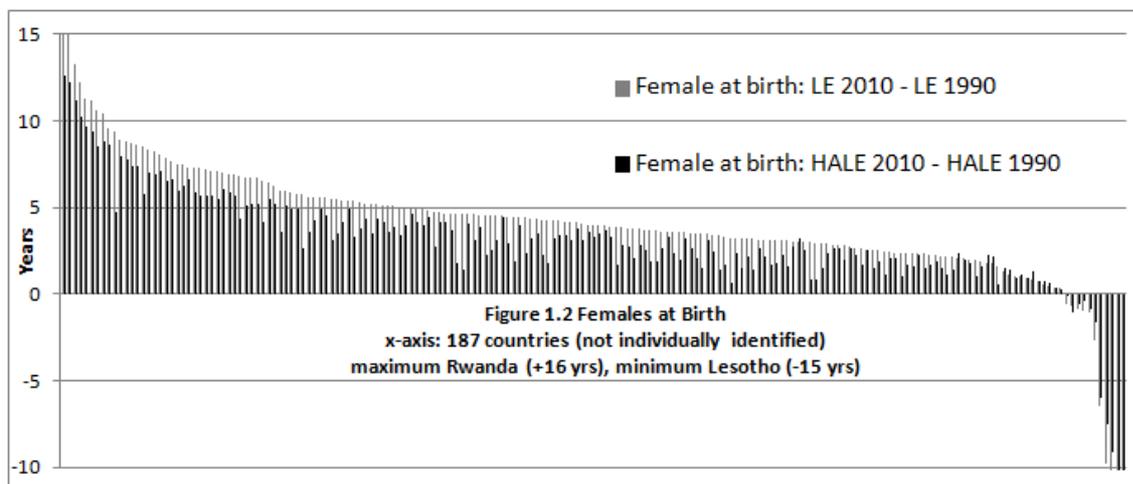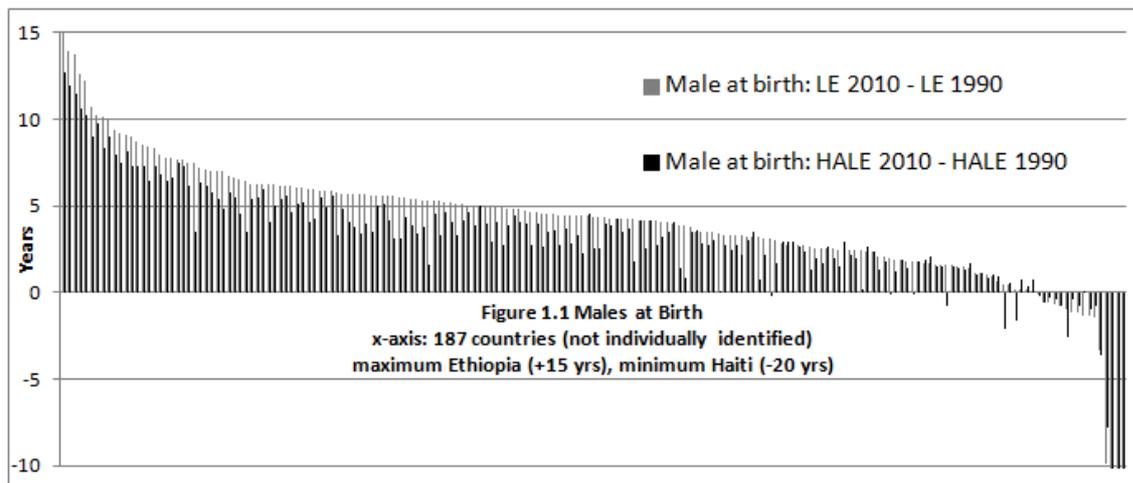|	Compression	Expansion
Absolute	$YLD_{2010} < YLD_{1990}$ $HALE_{2010} - HALE_{1990} > LE_{2010} - LE_{1990}$	$YLD_{2010} > YLD_{1990}$ $HALE_{2010} - HALE_{1990} < LE_{2010} - LE_{1990}$
Relative	$YLD_{2010} / LE_{2010} < YLD_{1990} / LE_{1990}$	$YLD_{2010} / LE_{2010} > YLD_{1990} / LE_{1990}$

Table 2 – Example of different cases of compression or expansion of morbidity, on an absolute and relative basis, following Howse [2]
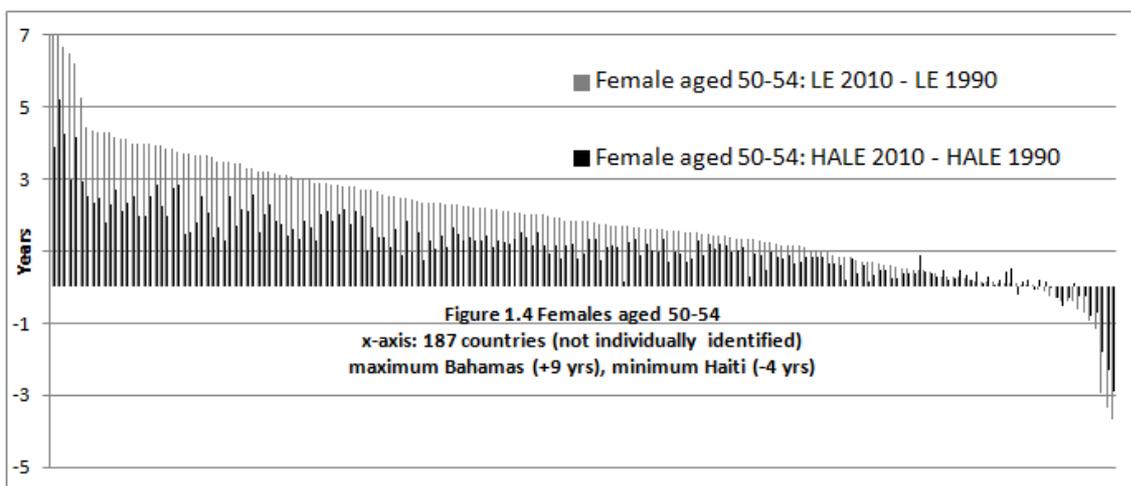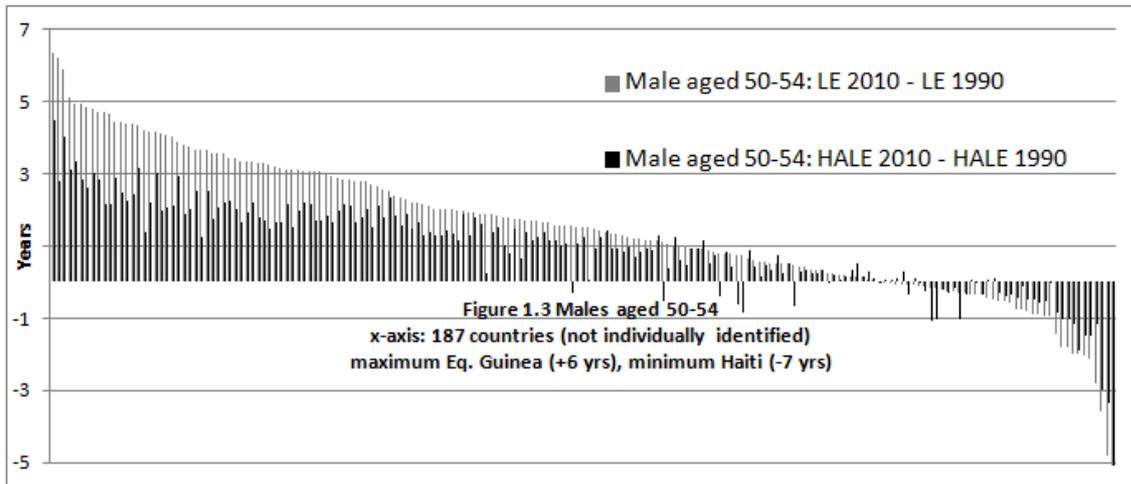
Example: (LE, HALE, YLD in years)	Total LE	Healthy LE (HALE)	Dependent LE (YLD)	YLD as a proportion of LE (YLD/LE)
State in 1990:	25	20	5	20%
1. Possible state in 2010:	31	23	8	26%
Classification:	Absolute expansion and relative expansion			
2. Possible state in 2010:	31	25	6	19%
Classification:	Absolute expansion with relative compression			
3. Possible state in 2010:	31	27	4	13%
Classification:	Absolute compression and relative compression			

Results and discussion

First the patterns of change in life expectancy (LE) and healthy life expectancy (HALE) by country are examined. This is done separately for males and females and at two ages, following Salomon et al, at birth and at age 50-54. The results for all countries are presented in order from largest to smallest increase in LE in years in Figure 1.

Figure 1 –Change in LE and HALE from 1990 to 2010 for 187 countries for (1) Males at birth, (2) Females at birth, (3) Males aged 50-54 and (4) Females aged 50-54, ordered by increase in LE.

Figure 1.1 Males at Birth
x-axis: 187 countries (not individually identified)
maximum Ethiopia (+15 yrs), minimum Haiti (-20 yrs)

Figure 1.2 Females at Birth
x-axis: 187 countries (not individually identified)
maximum Rwanda (+16 yrs), minimum Lesotho (-15 yrs)

Figure 1.3 Males aged 50-54
x-axis: 187 countries (not individually identified)
maximum Eq. Guinea (+6 yrs), minimum Haiti (-7 yrs)

Figure 1.4 Females aged 50-54
x-axis: 187 countries (not individually identified)
maximum Bahamas (+9 yrs), minimum Haiti (-4 yrs)

Life expectancy rises in nearly all countries for both ages and sexes. Healthy life expectancy also rises in nearly all cases, but rarely by as much as or more than life expectancy – these cases can be clearly identified by the occasional spike in the secondary data series. This is the basis of Salomon et al's conclusion that most countries are experiencing absolute expansion of morbidity. However relative measures of change may also be examined.

Table 3 provides a cross tabulation of the proportion of all 6,732 observations classified into expansion or compression of morbidity on both an absolute and relative basis.

Table 3 – Cross tabulation of the proportion of observations classified as a case of expansion or compression of morbidity, on an absolute and relative basis, for all countries and all age bands for (1) both sexes, (2) males (3) females and for all countries and both sexes for (4) birth and (5) age band 50-54.

3.1 Both sexes, all age bands, all countries.	Absolute Compression	Absolute Expansion	
Relative Compression	19.1%	14.7%	**33.8%**
Relative Expansion	2.8%	63.4%	**66.2%**
	21.9%	**78.1%**	**100.0%**
3.2 Males, all age bands, all countries.	Absolute Compression	Absolute Expansion	
Relative Compression	24.4%	12.5%	**36.9%**
Relative Expansion	3.1%	60.0%	**63.1%**
	27.5%	**72.5%**	**100.0%**
3.3 Females, all age bands, all countries.	Absolute Compression	Absolute Expansion	
Relative Compression	13.9%	16.8%	**30.8%**
Relative Expansion	2.4%	66.8%	**69.2%**
	16.3%	**83.7%**	**100.0%**
3.4 At birth, both sexes, all countries.	Absolute Compression	Absolute Expansion	
Relative Compression	13.6%	28.1%	**41.7%**
Relative Expansion	1.6%	56.7%	**58.3%**
	15.2%	**84.8%**	**100.0%**
3.5 Age 50-54, both sexes, all countries.	Absolute Compression	Absolute Expansion	
Relative Compression	16.6%	15.8%	**32.4%**
Relative Expansion	2.1%	65.5%	**67.6%**
	18.7%	**81.3%**	**100.0%**

While only 22% of all data points (Table 3.1) experienced absolute compression, 34% experienced relative compression, thus the proportion of remaining lifetime expected to be spent in poor health has reduced between 1990 and 2010 for a third of the observations. Clearly there is a high degree of correlation between the absolute and relative measures, although most exceptions were cases of relative compression in the presence of absolute expansion. When using a relative measure, there is less emphatic support for widespread expansion of morbidity, that is, a more optimistic picture of the proportion of expected remaining lifetime to be spent in ill health.

However the further panels in Table 3 show that outcomes for females were worse than for males (Tables 3.2 and 3.3), in both absolute and relative terms, and that the outcomes for older persons were worse than for younger persons (Tables 3.4 and 3.5).

The pattern of change by age can be further analysed as shown in Figure 2, which reinforces the previous observation of poorer outcomes for older persons compared to younger persons as well as consistently worse outcomes for females than males. Cases of both absolute and relative compression are very few for both males and females at all ages. There are more cases of relative compression with absolute expansion for females than males from birth through to age 55-59, but these are the only cases where female outcomes are better than those for males.
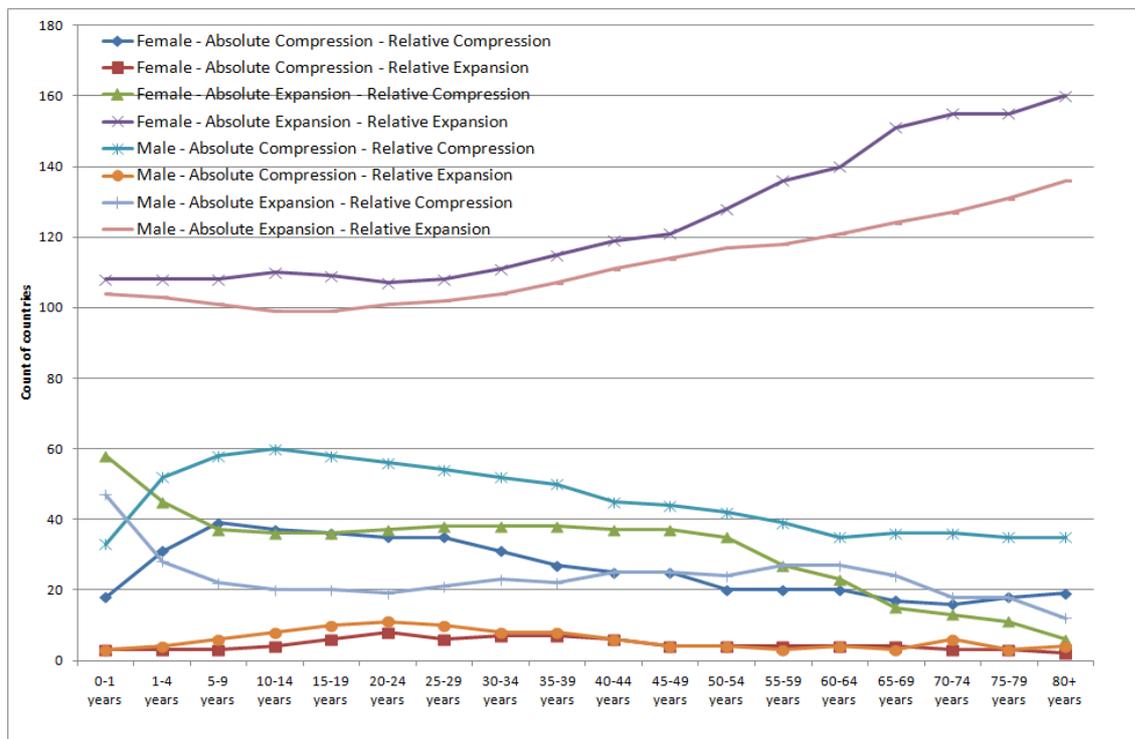
Figure 3 shows the overall proportion of remaining lifespan expected to be spent in poor health at a global level (averaged across countries, without weighting by population). In spite of increases in HALE, and the observation that on a relative basis evidence for expansion of morbidity is not as clear as on an absolute basis, we see that at every age, for both sexes, on average across countries, the world's population can expect to spend a greater proportion of their remaining expected lifetime in poor health in 2010 than in 1990.

The final figure in this article goes some way to illustrating why this is the case.

Figure 3 - Proportion of remaining lifetime expected to be spent in poor health in 1990 and in 2010, for males and females, by age band averaged across all countries (without weighting by population)
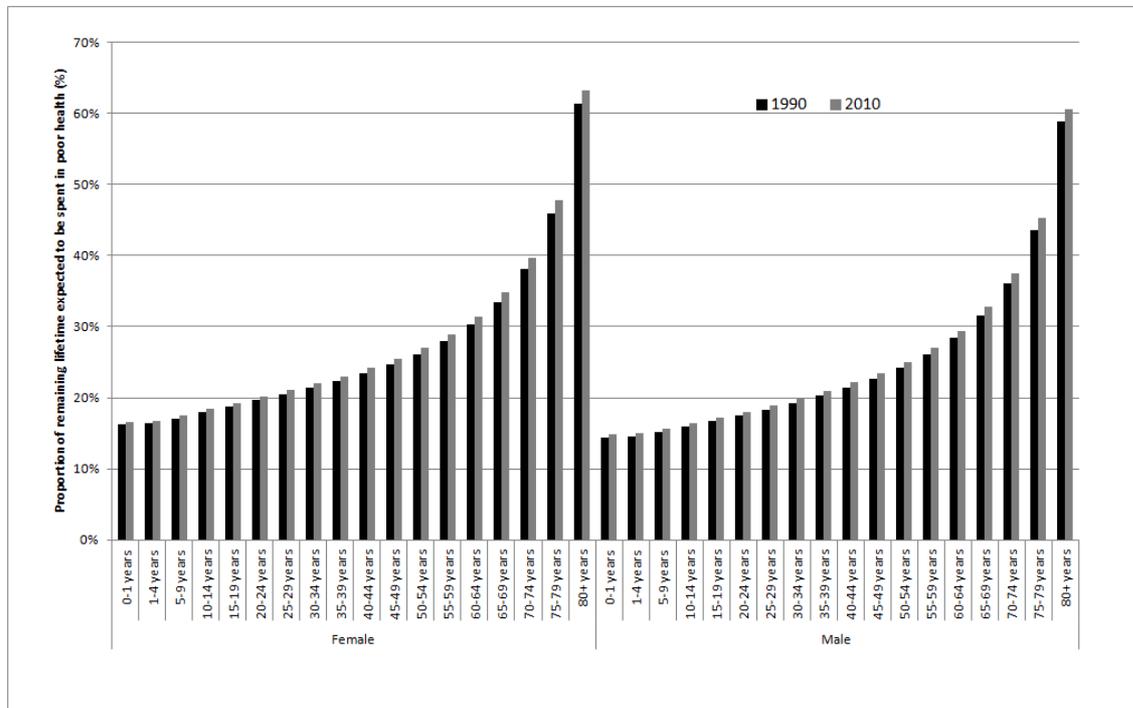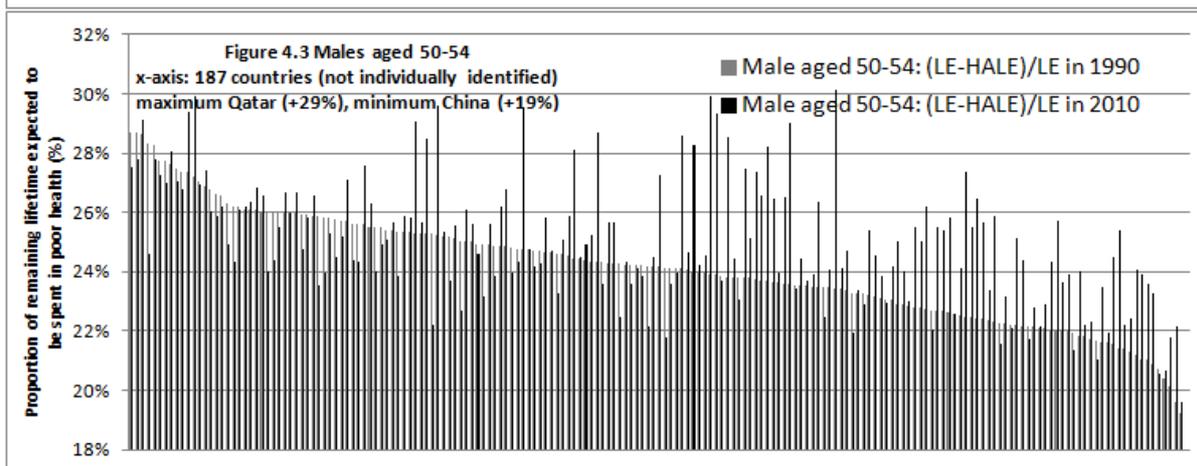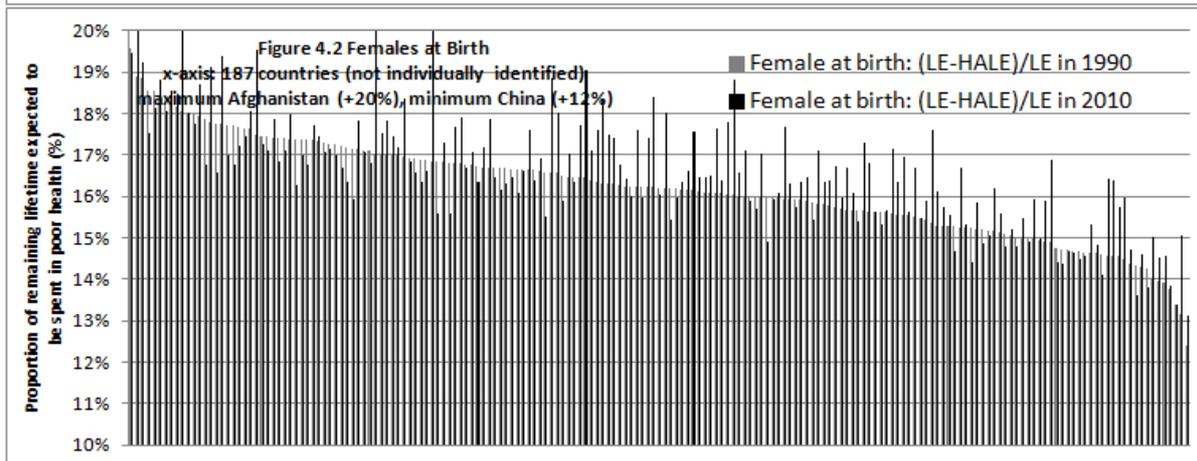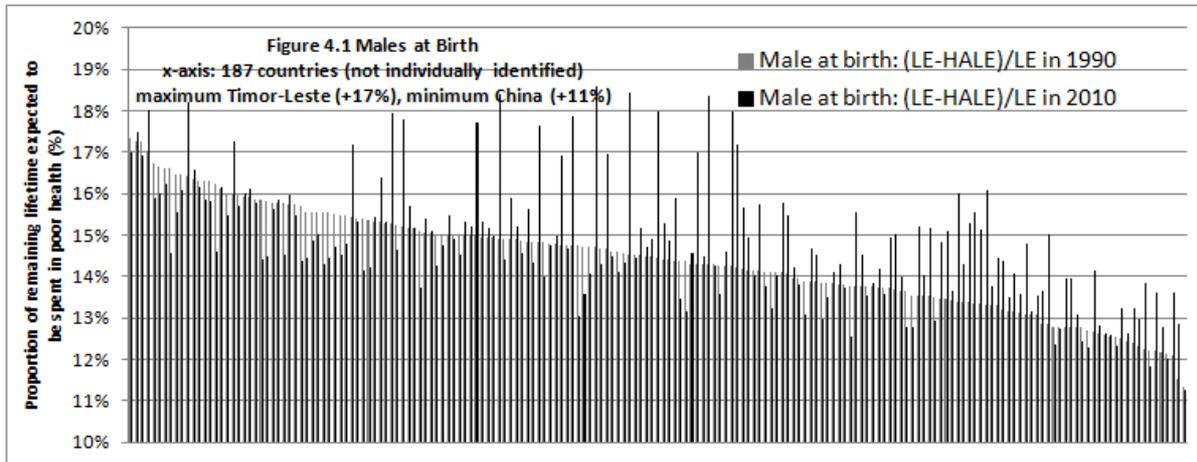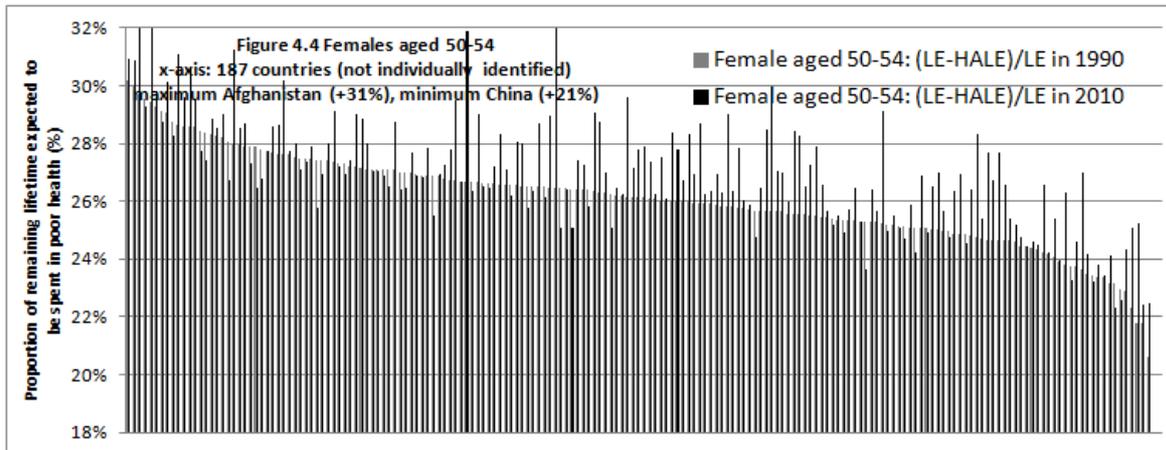

Figure 4 shows that where the proportion of remaining lifetime expected to be spent in poor health has declined between 1990 and 2010, these declines are less frequent and in general smaller than the cases where this proportion has increased. In several Caribbean countries the proportion has increased by over 25%.

From the global data we see that life expectancy has increased for almost all countries, ages and both sexes, with relatively few exceptions, from 1990 to 2010. Healthy life expectancy has also increased, almost as universally, although rarely by more than the increase in life expectancy itself.

Figure 4 –Proportion of remaining lifetime expected to be spent in poor health in 1990 and 2010 for (1) Males at birth, (2) Females at birth, (3) Males aged 50-54 & (4) Females aged 50-54, ordered by the proportion in 1990.

Figure 4.4 Females aged 50-54
x-axis: 187 countries (not individually identified)
maximum Afghanistan (+31%), minimum China (+21%)

■ Female aged 50-54: (LE-HALE)/LE in 1990
■ Female aged 50-54: (LE-HALE)/LE in 2010

Salomon et al define an increase in years lost to disability, being life expectancy minus healthy life expectancy, as an expansion of morbidity, but if healthy life expectancy is increasing at the same time, this absolute measure of change in morbidity may be helpfully complemented by consideration of relative changes, that is changes in the proportions of remaining lifetime expected to be passed in good and poor health.

Conclusion

In this article all available data is classified into cases of compression or expansion of morbidity on both an absolute and relative basis. Examining the entire dataset as well as the key points at birth and at age 50 (using as a proxy classes 0-1 and 50-54), a simple count of cases shows two different outcomes with many more cases of compression of morbidity when viewed on a relative basis.

However, on average, the proportion of life spent in poor health has in fact increased for both sexes and every age group at the global level. When changes country by

country are examined, it can be seen that this because the drop in those countries with a drop is relatively small compared to the increase in those countries with an increase.

Thus, though the higher number of cases of relative compression leads to a more optimistic view than that presented in Salomon et al, given the different levels of change between those countries with relative compression and those with relative expansion, at a global level the conclusion that there has been not only absolute but also relative expansion of morbidity is confirmed.

This study provides further support for Salomon et al's claim that "*HALE is an attractive indicator for monitoring health post-2015*" (ibid p 2144) by presenting a selection of possible additional analyses which demonstrate its value.

Author information

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