Comparing two inequality gap methods: Absolute Difference and the Slope Index of Inequality

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Introduction

Life expectancy (LE), healthy life expectancy (HLE) and their inequality gaps are important indicators in the Public Health Outcomes Framework (PHOF). The inequality gap in healthy life expectancy is a national indicator in the Well-being of Future Generations Act, which has previously been calculated using the Slope Index of Inequality (SII).

The Public Health Wales Observatory (PHWO) has historically used the Welsh Health Survey (WHS) to measure HLE and its inequality gap. Following the end of the WHS in 2015, this was no longer possible. Instead, PHWO decided to use the same survey as the Office for National Statistics (ONS), which is the Annual Population Survey (APS).

Due to concerns around the validity of the SII at local levels, the PHWO also decided to measure the inequality gap for LE and HLE using the absolute difference between the least and most deprived fifths. This report will outline the differences between the two methods and compare the results.

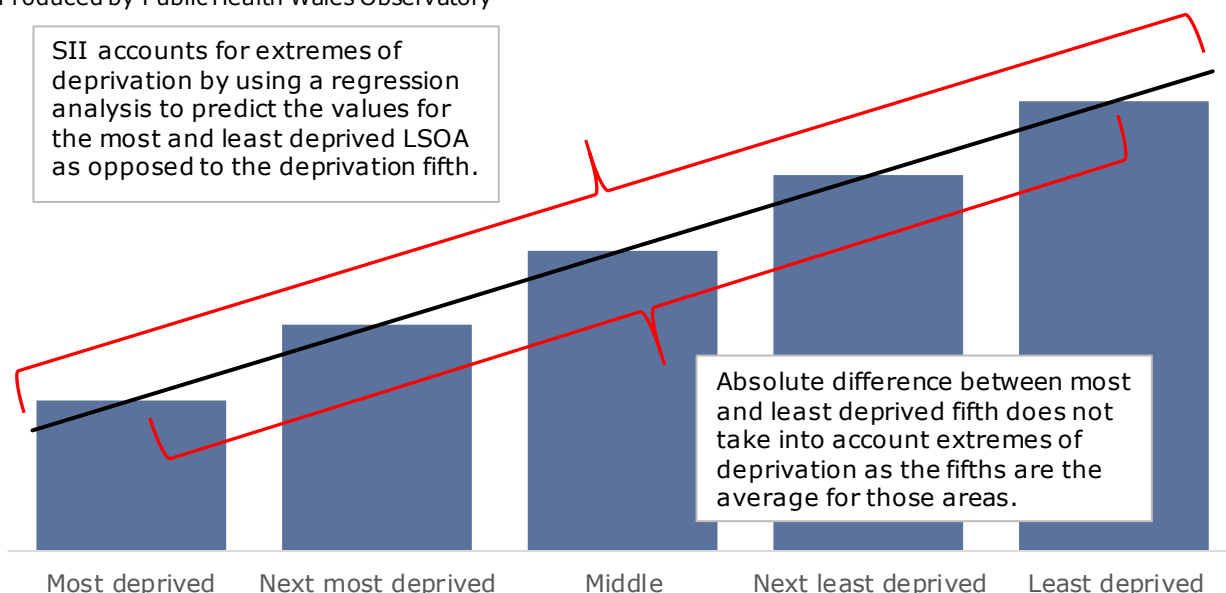# Absolute difference vs Slope index of inequality (SII)

Both methods measure the difference between the most and least deprived fifths. The absolute difference method simply subtracts the most deprived fifth from the least deprived fifth for a particular area. Further details of the methods used can be found in the appendix.

The slope index of inequality (SII) is a complex weighted measure that takes into account the other subgroups - deprivation fifths (or deprivation tenths in ONS's method) - using a regression model. The SII is therefore able to predict the values for the most and least deprived Lower Super Output Areas (LSOAs) as opposed to the most and least deprived fifths (figure 1).

While the SII may give a better indication of inequality in an area, it relies on a linear distribution of the deprivation fifths. If this is not the case, the confidence intervals (CI) surrounding the SII become very large. This is more often the case at local levels, where there may be little variation in deprivation across the area. For example, the CI for the HLE SII for Powys males in 2005-09 was -3.1 to 15.0 years i.e. such is the uncertainty in the SII calculation, the most deprived area may have a higher HLE than the least. These confidence intervals are often ignored when interpreting the SII, which can lead to misinterpretation of the data.

Figure 1: Example slope index of inequality (SII) vs absolute difference between least and most deprived fifths
Produced by Public Health Wales Observatory

SII accounts for extremes of deprivation by using a regression analysis to predict the values for the most and least deprived LSOA as opposed to the deprivation fifth.

Absolute difference between most and least deprived fifth does not take into account extremes of deprivation as the fifths are the average for those areas.

Most deprived   Next most deprived   Middle   Next least deprived   Least deprived

Results

Table 1 shows the inequality gap for LE and HLE in Wales using the two methods. For both males and females, the absolute difference method produces an inequality gap of around 80% of that identified using the SII. The confidence intervals for the two methods are similar, and appear at the Wales level to be sufficiently small to detect significant changes over time.

Table 1: Inequality gap in LE and HLE at birth, absolute difference and slope index of inequality, difference, CI range and percentage coverage, males and females, Wales, 2018-20

	Absolute difference				Slope Index of Inequality*				Percentage of SII
	Difference	LCL	UCL	CI range	SII	LCL	UCL	CI range	
Males									
Life expectancy	7.6	7.2	7.9	0.8	9.1	8.7	9.5	0.8	83.0
Healthy life expectancy	13.3	11.7	14.9	3.2	16.9	15.1	18.7	3.6	78.9
Females									
Life expectancy	6.3	5.9	6.6	0.7	7.7	7.3	8.1	0.8	81.3
Healthy life expectancy	16.9	15.3	18.5	3.2	20.2	18.4	22.0	3.6	83.8

Produced by Public Health Wales Observatory, using APS, PHM, MYE & Census 2011 (ONS) and WIMD 2019 (WG)
* SII confidence intervals have been calculated using a simulation programme

At local authority level, the inequality gap varies widely but the CI ranges remain broadly similar (table 2). Although there are limitations in using this measure to show change over time, it is the most precise estimate available – the confidence interval range for SIIs at local authority level calculated using the WHS could range up to 35 years.

Table 2: Inequality gap in HLE at birth, absolute difference and CI range, males and females, Wales local authorities, 2018-20

Area	Males				Females			
	Difference	LCL	UCL	CI range	Difference	LCL	UCL	CI range
Isle of Anglesey	7.8	2.4	13.1	10.7	7.4	1.7	13.2	11.5
Gwynedd	4.9	-1.0	10.7	11.7	1.7	-5.0	8.4	13.4
Conwy	18.8	13.2	24.3	11.2	13.8	7.4	20.2	12.9
Denbighshire	10.8	4.6	17.0	12.4	5.0	-1.9	12.0	13.9
Flintshire	9.9	3.9	15.9	12.1	14.4	8.3	20.5	12.2
Wrexham	18.8	12.2	25.4	13.2	10.6	4.7	16.5	11.9
Powys	15.2	8.6	21.8	13.1	2.8	-3.4	9.0	12.5
Ceredigion	1.6	-5.6	8.7	14.3	12.5	5.7	19.2	13.4
Pembrokeshire	15.1	9.7	20.4	10.8	3.3	-2.3	9.0	11.3
Carmarthenshire	10.8	5.2	16.4	11.1	8.9	2.7	15.0	12.2
Swansea	14.9	9.7	20.2	10.5	19.8	14.7	24.8	10.1
Neath Port Talbot	10.2	3.8	16.7	12.9	17.2	10.3	24.0	13.8
Bridgend	6.3	0.6	12.1	11.5	13.4	7.1	19.7	12.6
Vale of Glamorgan	17.9	11.5	24.4	12.8	19.3	11.8	26.8	14.9
Cardiff	13.7	7.8	19.5	11.7	18.5	12.8	24.3	11.5
Rhondda Cynon Taf	13.2	7.2	19.2	12.0	11.6	5.2	18.0	12.8
Merthyr Tydfil	14.3	7.5	21.0	13.5	11.8	4.2	19.5	15.3
Caerphilly	9.9	4.0	15.8	11.8	16.9	11.1	22.7	11.6
Blaenau Gwent	11.7	5.8	17.6	11.9	10.4	2.9	17.8	14.9
Torfaen	11.3	5.1	17.5	12.4	25.5	17.5	33.5	16.0
Monmouthshire	3.1	-2.2	8.4	10.6	7.7	2.3	13.2	10.9
Newport	12.6	7.0	18.2	11.2	25.5	18.9	32.1	13.2

Produced by Public Health Wales Observatory, using APS, PHM, MYE & Census 2011 (ONS) and WIMD 2019 (WG)

One limitation of the absolute difference method is that it does not necessarily measure the largest inequality gap in an area, just the inequality gap between the least and most deprived fifth. Table 3 shows HLE calculated for each deprivation fifth in Ceredigion. The HLE for males in the middle deprived fifth is over five years higher than the most deprived, but is not considered when calculating the absolute difference.

Table 3: Healthy life expectancy at birth, males and females, Ceredigion by deprivation fifth, 2018-20

Area	Males			Females		
	HLE	LCL	UCL	HLE	LCL	UCL
Least deprived fifth	58.9	53.6	64.1	71.3	67.5	75.1
Next least deprived fifth	64.3	59.8	68.9	65.8	61.2	70.4
Middle fifth	66.4	63.3	69.5	58.1	52.5	63.8
Next most deprived fifth	62.9	57.8	68.0	68.0	62.0	74.0
Most deprived fifth	60.5	55.8	65.1	58.9	53.2	64.5

Produced by Public Health Wales Observatory, using APS, PHM, MYE & Census 2011 (ONS) and WIMD 2019 (WG)

These situations generally occur where an area is relatively socially homogenous. Local WIMD fifths may therefore be created from a series of LSOAs that are ranked comparatively close together. This, combined with small sample sizes, can lead to a wider variation at local level in which the least and most deprived values are not necessarily the highest and lowest respectively.

Conclusion

PHWO has decided to use the absolute difference method for future calculations of the inequality gap in life expectancy and healthy life expectancy. It provides a comparable method at both national and local levels and has a consistent way of calculating confidence intervals. Although there are limitations to using the measure to compare over time, it remains the most precise estimate currently available. It is also technically easier to both measure and understand.

Although PHW will publish the absolute difference as part of future PHOF updates, the Office for National Statistics will continue to publish the SII at national level. There will therefore be two different measures of the inequality gap publically available at national level.

Appendix

LE and HLE method

Life expectancy (LE) and healthy life expectancy (HLE) have been calculated using the template created by ONS. LE is first calculated using the standard Chiang II abridged life table method. Good health estimates are then applied to the LE life tables to calculate HLE. This method combines good health data from the APS and 2011 Census to impute health prevalence at younger and older ages and smooth fluctuations for local estimates[1]. Full details of the methodology can be found here.

To calculate the inequality gap, LE and HLE were also calculated by deprivation fifth for Wales, health boards and local authorities using the Welsh Index of Multiple Deprivation 2019 (WIMD 2019). National fifths of deprivation are used for Wales where all the small areas in Wales are split between five equal bands of deprivation. Local fifths are used for health board and local authorities. Local fifths differ from national fifths in that the five equal bands of deprivation are recalculated just for the small areas within each health board and local authority boundary, rather than inheriting the national fifths. This is useful for a more localised approach to producing health expectancies. However, this also means that health board and local authority deprivation fifths may differ from one another.

For the HLE calculation, smaller sample sizes were observed at local authority level. This meant that imputation for a particular breakdown (area, sex, age and deprivation fifth) was required where there were no respondents, where there were no valid responses to the good health questions or where there were no individuals who responded that they were in good health. Where this occurred, weighted and unweighted data from the equivalent age band of the same breakdown in the next upper geography level was used i.e. for local authority this would mean imputing with its corresponding health board data. Where this occurs in an area broken down by deprivation fifth, the next upper geographical level was used to impute at the equivalent deprivation fifth. For example, Flintshire females aged 80-84 living in the next least deprived fifth would be updated with Betsi Cadwaladr females aged 80-84 living in the next least deprived fifth data. Investigations comparing various imputation methods were carried out and whilst no method was perfect, this method was shown to be more robust since in most cases it pulled from a greater pool of responses and resulted in less extreme differences when compared to the Census.

Inequality gap in LE and HLE

The inequality gap in LE and HLE was calculated by subtracting the most deprived fifth from the least deprived.

Confidence intervals were calculated using the difference between two sample means method[2], where the 'pooled' estimate of the standard deviation is given by:

$$s = \sqrt{\frac{(n_1-1)s_1^2+(n_2-1)s_2^2}{n_1+n_2-2}}$$

And the standard error is:

$$SE(d) = s * \sqrt{\frac{1}{n_1} + \frac{1}{n_2}}$$

s_1 and s_2 are the two sample standard deviations and n_1 and n_2 are the corresponding sample sizes. For LE, the sample size was determined to be the total population in each area. For HLE, the total unweighted count from the APS for each area was used.

References

1. Office for National Statistics. 2018. Health state life expectancies, UK QMI. Available from: https://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/methodologies/healthstatelifeexpectanciesukqmi [Accessed 31/10/2019]
2. Altman D.G. et al (2000) *Statistics with Confidence (2nd edn)* BMJ Books: UK (page 29)