Contextualising the effect of deprivation on health-related quality of life using the equivalent increase in weight as a surrogate

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Introduction

Area-level socioeconomic deprivation is an important predictor of health-related quality of life (HRQoL), with individuals living in more deprived areas experiencing worse health (Collins 2013; Drukker & van Os 2003; Kearns et al. 2013; Minet Kinge & Morris 2010). However, beyond describing the direction of this relationship, explaining the *felt* impact of neighbourhood deprivation on HRQoL can be difficult. Unlike measures such as life expectancy, HRQoL measures often operate on scales that are rather abstract, and thus less interpretable (Walters & Brazier 2005). For example, the measure 'EuroQol-5D' (EQ5D) contains a range of values between 1 (full health), 0 (dead) and -0.594 (with negative values representing states worse than death) (Rabin & Charro 2001). Although the extremes are understandable (to an extent), the meaning of changes in the measure are less interpretable.

This study proposes an approach for illustrating the effect that neighbourhood deprivation has on HRQoL. Our analysis demonstrates an approach through using changes in body mass index (BMI) to conceptualise the impact of deprivation. Utilising a meaningful summary measure helps to better contextualise the impact of an issue to a lay audience, as opposed to just the more abstract HRQoL measure (Ashley et al. 2014; Walters & Brazier 2005).

Data and Methodology

The study employs a cross-sectional design. A linear regression model was used to estimate the association between deprivation (most versus least deprived quintiles) and HRQoL separately for males and females, adjusting for known confounders including body mass index (BMI). Using the results from the regression models, the marginal effect of BMI on HRQoL was calculated separately for the most and least deprived quintiles of deprivation holding all other confounders at their mean values. The predicted HRQoL at mean BMI in the normal BMI group was then calculated in the most deprived quintile and the BMI value that would imply the same HRQoL in the least deprived quintile was calculated from the marginal effects. The difference between these two BMI values represents the effect of deprivation on HRQoL, transformed onto the BMI scale. To improve the interpretation further, the difference in weight rather than BMI was calculated for a person of mean height.

The relationship between BMI and HRQoL is u-shaped, with individuals who are either under or overweight having worse HRQoL than individuals of normal BMI (Kearns et al. 2013). Our analysis proposes a linear mapping of BMI onto HRQoL. For this to be justifiable, the analysis was restricted to those who are of normal BMI and above where the relationship is approximately linear. Conceptually, the approach only applies when BMI is used as a proxy for the effect of deprivation on HRQoL in the population of people who have normal BMI and above. There were few individuals who were underweight (BMI<18.5; n=192) and their exclusion had little influence on the results.

Data were taken from the first wave of the Yorkshire Health Study (formally the South Yorkshire Cohort), which took place between 2010 and 2012. The Yorkshire Health Study is a longitudinal observational cohort of individuals from the Yorkshire and Humberside region of England, with the first wave focused solely on the South Yorkshire region within it (Green et al. 2014). Data were self-reported.

Individuals living in the neighbourhoods classified in the most and least deprived quintiles in England were selected (n=10,145), as comparisons between these groups provide an intuitive sense of inequality. The 'Indices of Deprivation 2010' was used to measure neighbourhood deprivation using lower super output areas (mean population size 1,500) (Department for Communities and Local Government 2011). The measure provides a multi-dimensional measure of deprivation and has been widely used in previous health-related research (Collins 2013; Kearns et al. 2013; Minet Kinge & Morris 2010).

EQ5D was selected as the measure of HRQoL and the outcome variable in our analysis (Rabin & Charro 2001). EQ5D consists of five dimensions: mobility, self-care (problems washing or dressing self), usual activities (difficulty with work, study, housework, family or leisure activities), pain/discomfort and anxiety/depression. The measure is widely used in the NHS and is the National Institute for Health and Care Excellence's preferred measure of quality of life in economic evaluations (NICE, 2013).

Unmodifiable risk factors were defined as age, gender and ethnicity. Modifiable risk factors such as health conditions were included since these lie on the causal pathway in our model as moderators of the relationship to HRQoL and therefore form part of the explanation for differences between individuals. BMI was used to measure relative weight status, calculated through dividing weight (kg) by height-squared (m).

Results

Tables 1 and 2 present the results of the regression analysis for each gender. The model was centred on the mean BMI for individuals in the 'normal' BMI category (18.5-25 kg/m^2) for each gender (22.91 kg/m^2 for males and 22.32 kg/m^2 for females) to improve the interpretability of the results.

Table 1: Results of a linear regression with outcome EQ5D for males.

Variable	Coefficient	P	95% Confidence Interval	
			Lower	Upper
Age	-0.001	<0.001	-0.002	-0.001
Ethnic minority	0.016	0.242	-0.011	0.043
BMI	-0.005	<0.001	-0.006	-0.003
Deprivation	-0.103	<0.001	-0.118	-0.089
Diabetes	-0.075	<0.001	-0.099	-0.050
Breathing problems	-0.158	<0.001	-0.179	-0.138
High blood pressure	-0.038	<0.001	-0.056	-0.020
Heart disease	-0.069	<0.001	-0.094	-0.045
Osteoarthritis	-0.200	<0.001	-0.226	-0.173
Stroke	-0.140	<0.001	-0.180	-0.099
Cancer	-0.084	<0.001	-0.123	-0.044
Constant	0.995	<0.001	0.967	1.023
n	4536			
r^2	0.26			

Table 2: Results of a linear regression with outcome EQ5D for females.

Variable	Coefficient	P	95% Confidence Interval	
			Lower	Upper
Age	-0.002	<0.001	-0.002	-0.001
Ethnic minority	0.008	0.536	-0.018	0.034
BMI	-0.007	<0.001	-0.008	-0.006
Deprivation	-0.082	<0.001	-0.095	-0.069
Diabetes	-0.013	0.321	-0.039	0.013
Breathing problems	-0.127	<0.001	-0.146	-0.108
High blood pressure	-0.039	<0.001	-0.056	-0.022
Heart disease	-0.066	<0.001	-0.096	-0.036
Osteoarthritis	-0.195	<0.001	-0.215	-0.176
Stroke	-0.167	<0.001	-0.215	-0.119
Cancer	-0.050	0.008	-0.087	-0.013
Constant	1.010	<0.001	0.988	1.033
N	5609			
r^2	0.27			

The relationships for the variables were similar for both genders. There was a significant difference in HRQoL between individuals living in the most and least deprived areas. Individuals in the most deprived areas had a significantly lower quality of life than individuals in the least deprived areas. The coefficient for deprivation was greater for males than compared to females, suggesting that males are more susceptible to the impact of deprivation on their health. BMI was negatively associated with EQ5D, with a higher BMI being associated with a lower EQ5D.

The relationship between BMI and EQ5D by deprivation is shown in Figures 1 and 2. The graphs show the predicted value of EQ5D across each value of BMI for both individuals living in the most and least deprived areas, holding all other covariates from the regression models equal. There are clear negative slopes indicating the impact of increased relative weight on HRQoL. There is a smaller gap between the least and most deprived areas for females compared to males, indicating that the impact of deprivation is greater for males. However, the gradient for BMI is steeper for females than compared to males, suggesting that it has a larger impact on health for females.

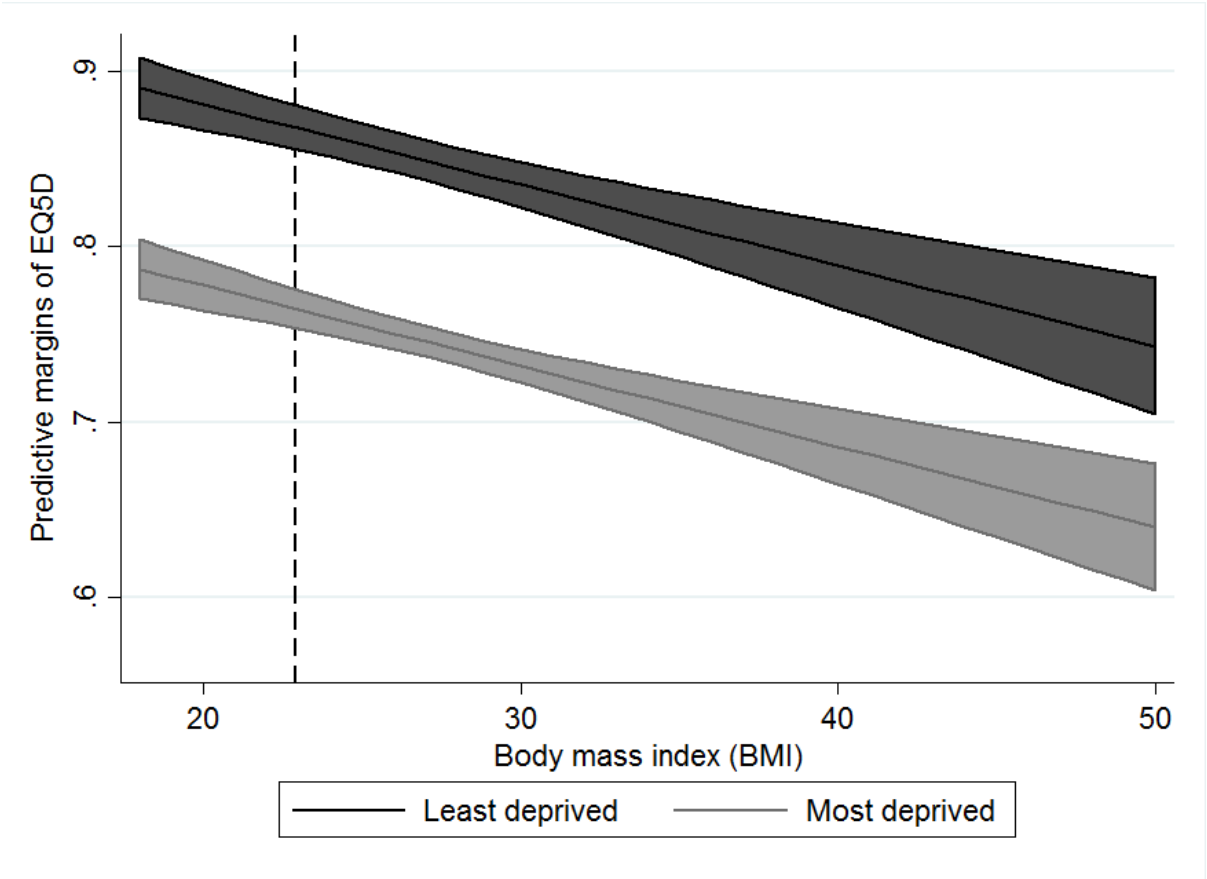

Figure 1: Predictive margins of EQ5D by neighbourhood deprivation and BMI (holding all else equal) calculated from the regression model for males (including a reference line for mean BMI in the normal BMI group).

A man of mean BMI in the normal BMI group (22.91 kg/m^2) who lives in the least deprived quintile has a predicted HRQoL of 0.103 units higher than the predicted value for a man of the same BMI living in the most deprived quintile. For women, the mean BMI in the normal BMI group is 22.32 kg/m^2, and the difference in predicted HRQoL between affluent and deprived areas is 0.082. The equivalent net increase in BMI (for someone of mean normal BMI living in the least deprived quintile) that would result in the same change in predicted EQ5D is 22.49 kg/m^2 if they were male, or 11.63 kg/m^2 if they were female. These increases in BMI equate to net increases of 69.67 kg for a man of average height (1.76m) and 30.52 kg for a woman of average height (1.62m).

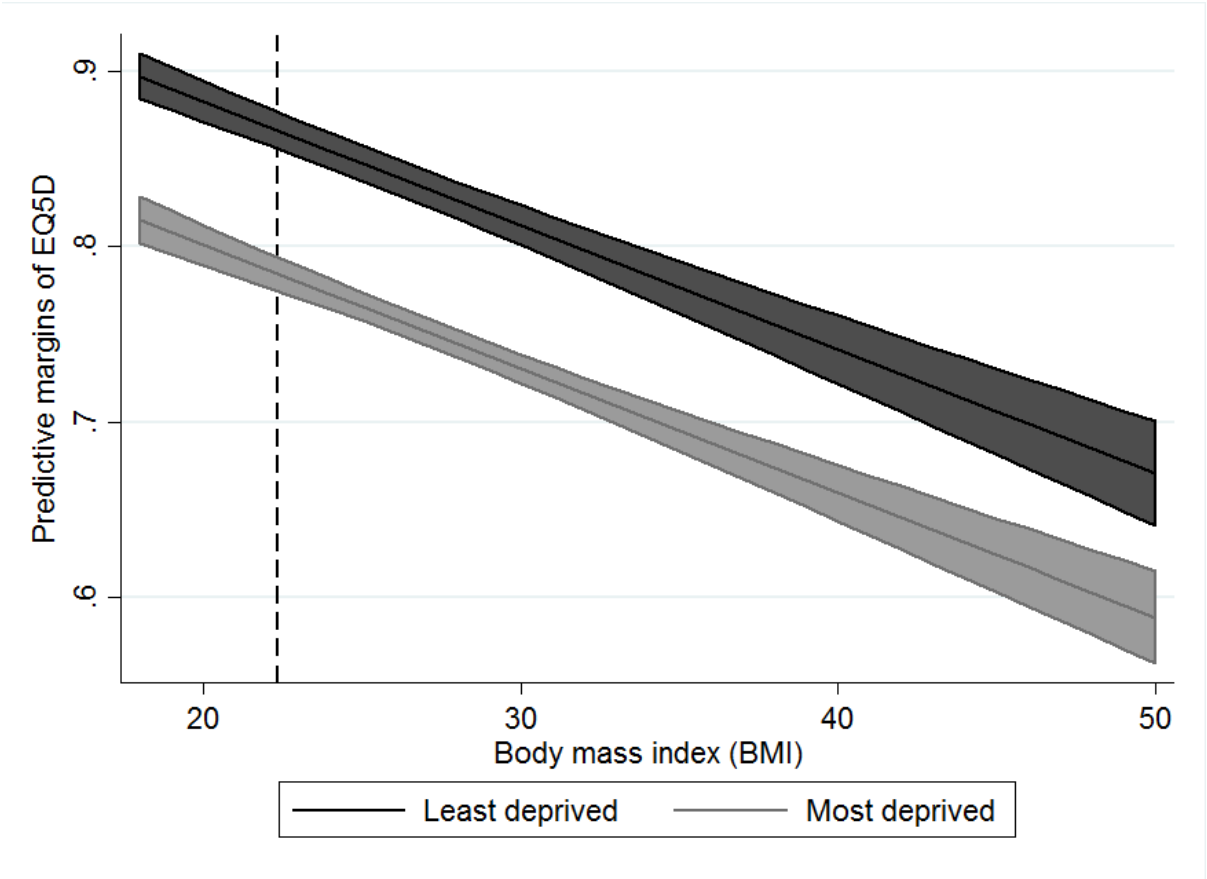

Figure 2: Predictive margins of EQ5D by neighbourhood deprivation and BMI (holding all else equal) calculated from the regression model for females (including a reference line for mean BMI in the normal BMI group).

Discussion

The analysis has presented a novel approach to illustrating the impact of deprivation on HRQoL. This approach may be particularly useful when communicating epidemiological results to a lay audience. Through comparing the impact of deprivation for the extremes of society to the impact of increased body weight, the effect that neighbourhood deprivation plays in determining quality of life is easier to conceptualise.

The magnitude of the weight changes that have been reported may appear surprising. However, an analysis of 57 prospective studies (894,576 participants in total) estimated that life expectancy lost for individuals who are morbidly obese (40-50 kg/m^2) is 8-10 years (Whitlock et al. 2009). Comparing this outcome to deprivation, the gap between the most and least deprived quintiles for male life expectancy

in England is estimated to be 7.9 (Public Health England 2013). Our estimate of the impact that deprivation has on quality of life using weight therefore seems appropriate.

Another important consideration is whether a 0.103 (for males) or 0.082 (for females) change in EQ5D is important. Walters and Brazier (2005) explored HRQoL across a range of health conditions (including leg ulcers, back pain, irritable bowel syndrome) to estimate the smallest change in EQ5D that can be regarded as beneficial to patients. They found that the mean minimally important difference across all conditions was 0.074 (range = -0.011 – 0.140) suggesting that the differences in EQ5D reported here are important.

References

Ashley, E.M., Nardinelli, C. & Lavaty, R.A., 2014. Estimating the benefits of public health policies that reduce harmful consumption. *Health Economics*, Advanced Access. Available at: http://onlinelibrary.wiley.com/doi/10.1002/hec.3040/abstract.

Collins, B., 2013. Using a survey to estimate health expectancy and quality-adjusted life expectancy to assess inequalities in health and quality of life. *Value in Health*, 16(4), pp.599–603.

Department for Communities and Local Government, 2011. *The English Indices of Deprivation 2010*, London: DCLG. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/6871/1871208.pdf.

Drukker, M. & van Os, J., 2003. Mediators of neighbourhood socioeconomic deprivation and quality of life. *Social Psychiatry and Psychiatric Epidemiology*, 38(12), pp.698–706.

Green, M.A. et al., 2014. Cohort Profile: The Yorkshire Health Study. *International Journal of Epidemiology*. Advanced Access. Available at: http://ije.oxfordjournals.org/content/early/2014/07/09/ije.dyu121.short.

Kearns, B. et al., 2013. Association between body mass index and health-related quality of life, and the impact of self-reported long-

term conditions -- cross-sectional study from the south Yorkshire cohort dataset. *BMC Public Health*, 13, p.1009.

Minet Kinge, J. & Morris, S., 2010. Socioeconomic variation in the impact of obesity on health-related quality of life. *Social Science & Medicine*, 71(10), pp.1864–71.

NICE, 2013. Guide to the methods of technology appraisal 2013. , (April). Available at: http://publications.nice.org.uk/guide-to-the-methods-of-technology-appraisal-2013-pmg9 [Accessed July 4, 2014].

Public Health England, 2013. Life expectancy by deprivation quintile. Available at: http://www.apho.org.uk/resource/item.aspx?RID=93390.

Rabin, R. & Charro, F., 2001. EQ-SD: a measure of health status from the EuroQol Group. *Annals of Medicine*, 33, pp.337–343.

Relton, C. et al., 2011. South Yorkshire Cohort: a "cohort trials facility" study of health and weight - protocol for the recruitment phase. *BMC Public Health*, 11, p.640.

Walters, S.J. & Brazier, J.E., 2005. Comparison of the minimally important difference for two health state utility measures: EQ-5D and SF-6D. *Quality of Life Research*, 14(6), pp.1523–32.

Whitlock, G. et al., 2009. Body-mass index and cause-specific mortality in 900 000 adults: collaborative analyses of 57 prospective studies. *Lancet*, 373(9669), pp.1083–96.

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