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) and weight 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 (split as quintiles) and HRQoL separately for males and females, adjusting for known confounders including 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 expected reduction in HRQoL associated with living in the poorest fifth of areas, compared with living in the least deprived areas. 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 (n=18,740). 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.

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).

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). Whilst we included all observations to improve our estimates, we chose to focus

on comparisons between individuals living in the most and least deprived quintiles since comparisons between these groups provide an intuitive sense of inequality.

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. Smoking status, the number of units of alcohol consumed in a week and level of physical activity per week (reported as categories; 'none', 'less than one hour', 'one to three hours' and 'greater than three hours') were also included since they are risk factors for poor health (Lim et al. 2012). 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).

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	-0.001	-0.001
Ethnic minority	-0.002	0.876	-0.026	0.022
BMI	-0.005	<0.001	-0.006	-0.004
Deprivation quintile:				
1 (Least deprived)	Reference			
2	-0.008	0.245	-0.023	0.006
3	-0.021	0.010	-0.036	-0.005
4	-0.050	<0.001	-0.066	-0.035
5 (Most deprived)	-0.086	<0.001	-0.101	-0.071
Diabetes	-0.042	<0.001	-0.059	-0.025
Breathing problems	-0.126	<0.001	-0.141	-0.112
High blood pressure	-0.016	0.009	-0.028	-0.004
Heart disease	-0.062	<0.001	-0.080	-0.044
Osteoarthritis	-0.213	<0.001	-0.230	-0.196
Stroke	-0.113	<0.001	-0.142	-0.085
Cancer	-0.084	<0.001	-0.111	-0.058
Smoke	0.020	<0.001	0.017	0.024
Units of alcohol	0.001	0.004	0.000	0.001
Physical Activity:				
None	Reference			
Less than one hour	0.052	<0.001	0.035	0.069
One to three hours	0.062	<0.001	0.049	0.075
More than three hours	0.070	<0.001	0.058	0.082
Constant	0.869	<0.001	0.842	0.896
n	8505			
r^2	0.28			

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	-0.002
Ethnic minority	-0.011	0.371	-0.034	0.013
BMI	-0.006	<0.001	-0.007	-0.005
Deprivation quintile:				
1 (Least deprived)	Reference			
2	-0.006	0.335	-0.018	0.006
3	-0.013	0.059	-0.026	0.001
4	-0.030	<0.001	-0.044	-0.017
5 (Most deprived)	-0.060	<0.001	-0.073	-0.046
Diabetes	-0.026	0.012	-0.046	-0.006
Breathing problems	-0.090	<0.001	-0.104	-0.077
High blood pressure	-0.025	<0.001	-0.037	-0.013
Heart disease	-0.092	<0.001	-0.114	-0.070
Osteoarthritis	-0.184	<0.001	-0.197	-0.170
Stroke	-0.149	<0.001	-0.184	-0.114
Cancer	-0.053	<0.001	-0.078	-0.027
Smoke	0.015	<0.001	0.012	0.018
Units of alcohol	0.002	<0.001	0.001	0.002
Physical Activity:				
None	Reference			
Less than one hour	0.028	<0.001	0.014	0.041
One to three hours	0.049	<0.001	0.039	0.059
More than three hours	0.064	<0.001	0.052	0.076
Constant	0.911	<0.001	0.889	0.933
n	10235			
r^2	0.30			

Results 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 effect of 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. Including an interaction term between BMI and deprivation did not improve the model for either males or females, and hence was not included in the final analysis.

The relationship between BMI and EQ5D for those in the most and least deprived quintiles 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 at their mean values. The negative impact of increased weight on HRQoL is clear. 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.

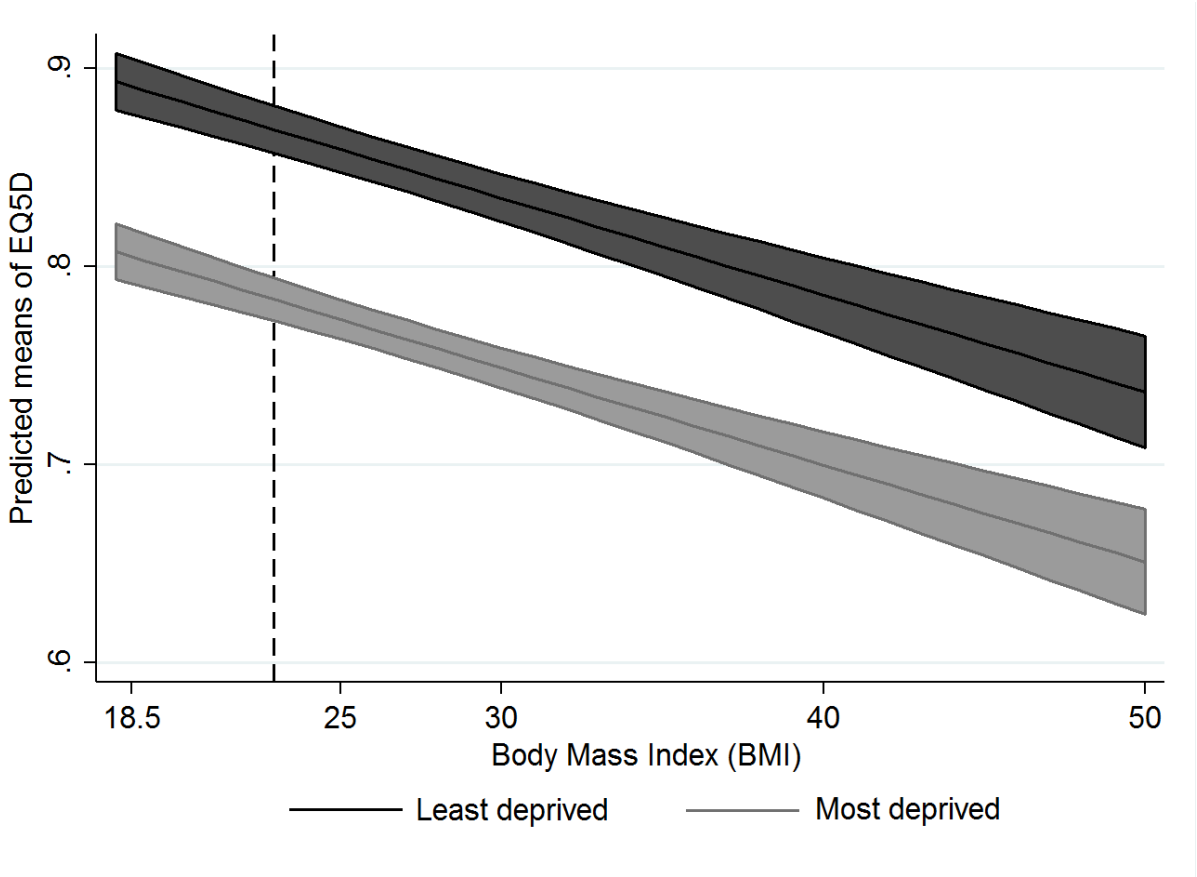

Figure 1: Predictive margins of EQ5D by neighbourhood deprivation and BMI (holding all other covariates at their mean values) calculated from the regression model for males (including a reference line for mean BMI in the normal BMI group).

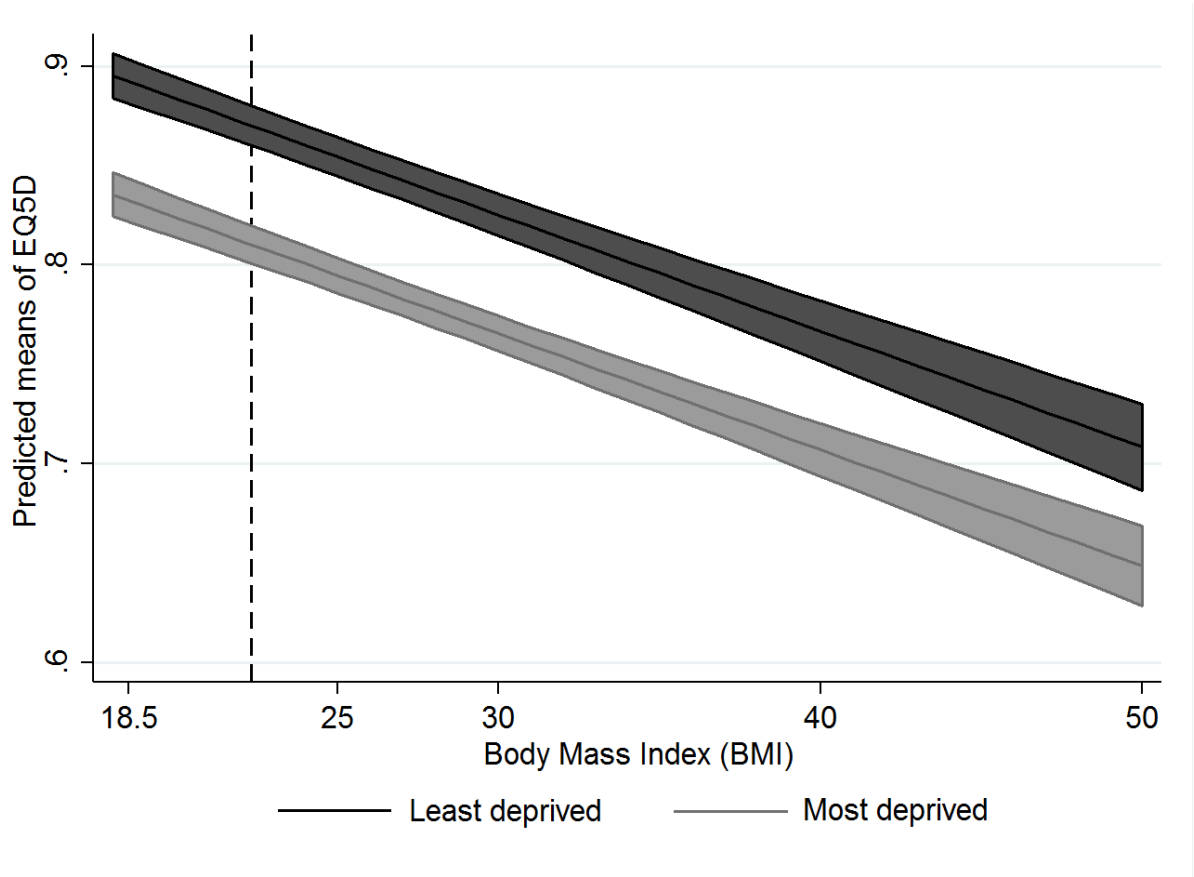

Figure 2: Predictive margins of EQ5D by neighbourhood deprivation and BMI (holding all other covariates at their mean values) calculated from the regression model for females (including a reference line for mean BMI in the normal BMI group).

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 17.56 kg/m^2 if they were male, or 10.23 kg/m^2 if they were female. These increases in BMI equate to net increases of 54.39 kg for a man of average height in the least deprived quintile (1.76m) and 26.85 kg for a woman of average height in the least deprived quintile (1.62m).

Discussion

This paper has presented a novel approach to illustrating the impact of deprivation on HRQoL. The approach may be particularly useful when communicating epidemiological results to a lay audience. By comparing the impact of deprivation with 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 years (Public Health

England 2013). Our estimate of the impact that deprivation has on quality of life using weight therefore seems plausible.

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 to 0.140) suggesting that the differences in EQ5D reported here are important.

The results have demonstrated that deprivation and BMI are independently associated with HRQoL. However, deprivation and BMI are positively correlated in the population. This means that if either covariate is absent from a regression analysis with HRQoL as the outcome, there is potential for confounding. The finding that a large increase in weight is necessary for a person to have the same felt impact on HRQoL as they would have if they were to move between the most and least deprived quintiles suggests a relatively weak marginal effect of BMI on HRQoL. This challenges the assumption that obesity itself is a strong predictor of poor HRQoL. If an analysis of the association between BMI and HRQoL does not include a measure of socioeconomic deprivation, then the estimate of the effect of BMI on

HRQoL will be overestimated. Deprivation will be the 'lurking' confounder that explains much of the difference in HRQoL that is mistakenly attributed to BMI.

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