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The Socioeconomic Gradient of Obesity in Ireland

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Abstract: Using the nationally representative Slan dataset we calculate concentration indices for the incidence of obesity for men and women. We finder higher concentration indices for women than for men, but we also find that concentration indices fell between 2002 and 2007. However this appears to be owing to an increased incidence of obesity amongst better off people rather than decreased obesity amongst the less well-off. A decomposition of the concentration indices suggest that the greatest contribution to the gradient comes from the combination of lower rates of obesity amongst those with 3rd level education and their higher income.

Keywords: Obesity, Body Mass Index, Concentration Index, decomposition.

JEL Codes: I12, I31, I32

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1. Introduction

There is now fairly substantial evidence worldwide of a socioeconomic gradient in obesity for developed countries (McLaren, 2007). The incidence of obesity (defined as a body mass index in excess of 30) tends to fall as socioeconomic status increases. The phenomenon is observed for a variety of measures of socioeconomic status (such as income, education, occupation) and tends to be more pronounced for females.

However, there is relatively little recent evidence concerning the socioeconomic gradient of obesity in Ireland. Whelton et al (2007) examine the prevalence of obesity in Ireland amongst children using data from 2001-2002 and concluded that there was no consistent trend in the prevalence of obesity according to socioeconomic disadvantage, which they measured by the presence of a medical card (this grants free access to primary health care and its availability is determined by a means test). However, there is little formal measurement of the socioeconomic gradient in obesity for Irish adults. This paper attempts to fill this gap. We calculate concentration indices for obesity for 2002 and 2007 using nationally representative samples from the Irish population. The concentration index is a standard measure of association which indicates the degree to which a condition such as obesity varies with a continuous measure of household resources, such as income or expenditure. It has the attractive property that it provides a single index of income related inequality in obesity and it can also be used in decomposition analysis of the factors lying behind such income related inequality. In the next section of this paper we briefly discuss the

concentration index, as well as some specific methodological issues which can arise in its application to obesity. We also explain how it can be decomposed. We then describe our data and present and discuss results for concentration indices and their decomposition.

2. The Concentration Index

Suppose we have a health variable, h, where h_i is the value of that variable for individual i. Then if r_i is the fractional rank of individual i in the income distribution (or whatever measure of household resources is being used), then the concentration index is

$$C = \frac{2 * \text{cov}(h_i, r_i)}{\mu_h}$$

where μ_h is the mean value of the health variable (Kakwani et al, 1997). C can take on a value from -1 to +1, where a negative (positive) value indicates that the health variable is concentrated among the relatively poor (rich). Since obesity can be regarded as a reflection of ill-health, a negative value of C will indicate a situation favouring the better-off and so could be regarded as pro-rich inequality.

One attractive property of the concentration index is that it is possible to decompose C into inequalities and elasticities of health determinants. If the vector $\boldsymbol{X}$ refers to those variables influencing h, then if we assume that the health variable can be described by a linear regression of the form

$$h_i = \alpha + \beta_k X_{ki} + \varepsilon_i$$

then C can be written as

$$C = \sum_k \left(\frac{\beta_k \bar{x}_k}{\mu_h} \right) C_k + \frac{GC_\varepsilon}{\mu_h}$$

where the index *k* refers to the regressors in the equation, C_k is the concentration index for each of the individual regressors, β_k is the coefficient for each health determinant and $\bar{x}_k$ is the mean value of each individual regressor. GC_ε is the generalised *C* for the residual from the regression.

It is also possible to use the above specification to decompose the change in *C* over two periods. Thus where *0, 1* indicates two time periods we have

$$C_1 - C_0 = \sum_k \eta_{k1}(C_{k1} - C_{k0}) + \sum_k C_{k0}(\eta_{k1} - \eta_{k0}) + \frac{GC_{\varepsilon 1}}{\mu_{h1}} - \frac{GC_{\varepsilon 0}}{\mu_{h0}}$$

and η_{ki} refers to the elasticity of regressor *k* for period i. The decomposition over time above is similar to the well-known Blinder-Oaxaca type decomposition (Blinder, 1973, Oaxaca, 1973). The first term on the right-hand side refers to changes in income related inequality in the determinants of obesity, while the second term captures the change arising from changes in the elasticities of obesity with respect to these determinants.

The analysis above refers to the situation where the health variable is continuous. In the case of the incidence of obesity h_i is a binary variable which takes on values of 0 or 1. In this case a normalisation must be applied to the concentration index (since the bounds would not be -1 and +1). Wagstaff (2005) suggested a normalisation of $C_n = C/(1-\mu_h)$. In a recent contribution Erregeyers (2009a) suggested that the appropriate normalisation be $C_E = 4\mu_h C = 4\mu_h(1-\mu_h)C_n$. The subsequent debate (see Wagstaff, 2009 and Erregeyers, 2009b) indicates that the issue is not quite

resolved yet. In our analysis here we will apply the Erregeyers normalisation to the concentration index and its decomposition (we also carried out the analysis using the Wagstaff correction and the qualitative results were very similar, results available on request).

If we are concerned with the socioeconomic gradient of the *incidence* of obesity, then clearly we must treat obesity as a binary variable. The most common definition of obesity is that suggested by the World Health Organisation (WHO) who suggest that a body mass index (BMI) in excess of 30 constitutes obesity. [1] In this instance the normalised concentration index would appear to be the appropriate measure. However we may also be concerned with the *intensity* of obesity, conditional on someone being obese, as risk factors may increase with BMI. For example, Ha Jee et al (2006) present graphs of hazard ratios for death from a number of different causes against BMI for a sample of Korean adults. The graphs of the hazard ratios show risk ratios clearly increasing with BMI, in some cases non-linearly. In that case we may wish to calculate the BMI concentration index for the obese population by simply applying the formula for C to the population with BMI in excess of 30. We could label this the *Conditional Concentration Index*.

It could be asked, why not simply calculate the concentration index for the total distribution of BMI? The reason we do not do this is because, from a public policy point of view, we are not concerned with how the distribution of BMI varies with household resources below the critical threshold of 30. While the extent to which

[1] There is criticism of BMI as a measure of obesity with some authors suggesting that other measures such as total body fat, percent body fat and waist circumference are superior measures of fatness (see Cawley and Burkhauser, 2006). Notwithstanding these arguments we still feel it is most appropriate to

BMI below 30 varies with household resources may be of interest in its own right, we argue that it is not of relevance in the context of the socioeconomic gradient of obesity, presuming we accept the WHO obesity thresholds.

3. Data and Results

Our data comes from the Survey of Lifestyle, Attitudes and Nutrition in Ireland, usually known as the Slán survey. The Slan surveys were carried out in 1998, 2002 and 2007. For our purposes in this paper, the correspondence between the questions asked in 2002 and 2007 is closest and so it is these two years which form the basis of our study. The Slan surveys are comprehensive, nationally representative surveys with sample sizes in 2002 and 2007 of 5992 and 10364 respectively. It is worth pointing out that Slan 2007 was a face-to-face interview in the respondent's house, while Slan 2002 was a self-completed postal survey. Both approaches have their advantages and disadvantages: while interviewers can prompt and provide help to respondents in a face-to-face situation, the presence of the interviewer may affect the response to some questions. In the case of the self-reported survey there is always the danger than some respondents may not fully understand the question. Morgan et al (2008) provide greater detail.

The particular measure of household resources which we use is equivalised net income. Respondents are asked to give their best estimate of net household income of *all* members of the household. This is done by presenting respondents with a set of cards where they locate their income within a set of broad intervals. They are then

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apply our approach to obesity as measured by BMI, as the likelihood is that it will remain the most

presented with a set of cards with narrower income intervals and we chose the midpoint of those intervals as their income. This income level was then equivalised by dividing by the square root of household size. As pointed out by Clark and Van Ourti (2009) the use of grouped income data can lead to underestimation of the concentration index. However the application of the equivalence scale here gives rise to within group variation in income and the number of income groupings is also sufficiently high for us to believe that the use of grouped data does not lead to any serious underestimation.

Before examining the data for socioeconomic gradient, we first present summary statistics for BMI for the two years in question. Note we trim the data of the top and bottom 0.5% by BMI for fear of very large and very small values reflecting measurement error. Table 1 provides some information on BMI for 2002 and 2007. We can see that mean and median BMI have both increased slightly (by less than one per cent). The overweight rate (percentage of the sample with BMI over 25) has increased by about two per cent while the obesity rate (percentage of the sample with BMI over 30) has increased by less than one per cent.

Table 2 provides the same information, except this time by gender, and we note that rates of obesity (and overweight) are virtually unchanged for men, yet have risen for women. This indicates that women account for practically all the increase in obesity recorded in table 1.

commonly used indicator of obesity for the foreseeable future.

In table 3 we provide calculation of concentration indices for the incidence of obesity and also the conditional concentration indices for obesity for men and women for 2002 and 2007. Dealing first with the incidence of obesity, we note that the index for the incidence of obesity is about twice as large for females, as for males. We also note that the index for both genders has fallen over the period, with a more pronounced fall for females. However, since overall obesity rates are pretty much unchanged for men, while they have risen for women, this implies that the reduction in the gradient is occurring not because of reduced obesity amongst the less well-off, but rather owing to increased relative obesity amongst the better-off, and this phenomenon is more pronounced for women.

The results for the conditional concentration indices indicate that the degree of socioeconomic gradient of BMI, *conditional on being obese*, is not statistically different from zero. Given the lack of a significant (in the economic and statistical sense) socioeconomic gradient for the intensity of obesity, we confine our subsequent analysis and decomposition of the concentration curve to the incidence of obesity.

Thus we can summarise the first set of results as follows: the socioeconomic gradient in obesity is exclusively confined to the incidence of obesity rather than what we might call the intensity of obesity. It is also the case that the socioeconomic gradient is more pronounced for women than for men, and while the gradient did decline over the 2002-2007 period this was owing to increased relative obesity amongst the better-off, rather than reduced obesity amongst the less well-off.

We now move on to the decomposition of the concentration index. First, we need to choose a set of regressors which might plausibly influence BMI. On the basis of what is available in the Slan survey and what might affect obesity, we choose the following: age (and age squared to allow for a non-linear relationship), general self-assessed health status[2], smoking status, education, marital status, principal economic status and equivalised income.

Tables 4 and 5 show the (i) the elasticities of each of these covariates with respect to obesity (ii) the concentration index for each of the covariates and (iii) the contribution of each covariate to the overall concentration index (which is the product of (i) and (ii)). We present results for both men and women and for 2002 and 2007. The elasticities are computed from an OLS regression of obesity on the covariates. While in general it is preferable to estimate binary models using a probit or logit, since the decomposition only works with a *linear* relationship, we follow standard practice in the literature (e.g. Ljungvall and Gerdtham, 2010) and use a linear probability model.

Dealing with men first, table 4 shows that the highest elasticities are with respect to age and age squared. However, when we take account of the concentration indices for these two covariates and add them together to get the overall effect we see that age makes a relatively small contribution to the overall index. For men, the biggest contribution to obesity comes from third level education (relative to the omitted category, primary education). Here the elasticity ranges between -0.12 and -0.17 and perhaps more importantly, the concentration index for third level education is high

[2] Self assessed health is based upon the answer to the question "In general would you say your health is poor/fair/good/very good/excellent". We use this as a simple cardinal variable in the analysis. Changing it to a binary variable (portioning it between excellent/very good and poor/fair/good) makes very little difference to the results).

(third level education is concentrated amongst the better-off). It is worth bearing in mind that the elasticity for third level education refers to a situation where an individual would "switch" from primary education only to third level education, which is arguably not a realistic switch to make.

Self-assessed health also makes a substantial contribution to the index. This arises from the combination of relatively high elasticities of obesity with respect to health (ranging from -0.79 to -0.91) and a positive concentration index for health. It is interesting to note that factors such as smoking have little impact on the overall index.

Table 5 presents the same results for women. Once again and bearing in mind that the overall value of the index is higher for women than for men, self-assessed health and third level education make the biggest contribution to the index. However, there is also a relatively larger contribution from equivalised income. This reflects the fact that the (absolute value of the) elasticity of obesity with respect to income for women is substantially greater than for men (-0.11 compared to -0.014). The residual, or unexplained element of the concentration index, is also higher for women, particularly in 2002.

Table 6 provides a breakdown of the change in the concentration indices for men and women between 2002 and 2007. In both cases the absolute value of the index falls, with a greater fall for women than for men. What is perhaps of greater interest is the breakdown of the change between changes in the elasticities and changes in the individual concentration indices. For the case of men, by far the biggest contribution to the fall in the concentration index came from changes in the individual

concentration indices. Most notably, there was a fall in the concentration index for third level education, from 1.37 to 1.15. There was also a fall in the index for age (adding together the contributions from age and age squared) and a fall in the concentration index for equivalised income (reflecting lower income inequality). On the elasticities side, a fall in the obesity elasticity with respect to third level was the main individual contributor.

In the case of women, the bulk of the fall is accounted for by changes in elasticities (about 55%) as opposed to changes in concentration indices and there is also a much greater residual component. The main portion of the change in elasticities is accounted for by a reduction in the (absolute value of the) health elasticity of obesity, from -1.6 to -0.9. The overall effect of age also makes a contribution, as does the elasticity of obesity with respect to being on home duties as opposed to the default category of employment. For that proportion of the fall in the overall concentration index accounted for by changes in the individual concentration indices, the biggest contribution comes from third level education, where the concentration index falls from 1.22 to 1.04. Reduced income inequality, reflected in the lower concentration index for income, is also a contributory factor.

4. Conclusion

This paper has provided a formal analysis of the socioeconomic gradient in obesity in Ireland. Probably the principal results are that the gradient is more pronounced for women than for men and that it has declined between 2002 and 2007. This decline however has arisen owing to increased obesity amongst the better-off as opposed to lower obesity amongst the less well-off.

We also provide a regression-based decomposition of income related inequality in obesity. The main contributors are self-assessed general health and third-level education. Both factors are negatively related to obesity, yet positively related to income and this combination leads to them contributing to income related inequality in obesity. The contribution of third level education declined between 2002 and 2007 as its presence became less concentrated amongst the better-off.

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Table 1: BMI Summary Statistics, 2002 and 2007

Year	Mean	Median	% above 25	% above 30
2002 (N=4755)	25.459	24.856	0.488	0.136
2007 (N=8460)	25.642	25.141	0.511	0.145

Table 2: BMI Summary Statistics, 2002 and 2007, by Gender

Year	Female			
	Mean	**Median**	**% above 25**	**% above 30**
2002 (N=2775)	24.842	24.033	0.402	0.120
2007 (N=4768)	25.075	24.324	0.432	0.132
	Male			
	Mean	**Median**	**% above 25**	**% above 30**
2002 (N=1980)	26.322	25.989	0.608	0.158
2007 (N=3692)	26.374	26.062	0.612	0.161

Table 3: Concentration Indices for Obesity (BMI>30, standard error in brackets)

Year	Incidence		Conditional *C*	
	Male	Female	Male	Female
2002	-0.293 *(0.055)*	-0.594 *(0.057)*	-0.002 *(2.022)*	-0.007 *(2.019)*
2007	-0.179 *(0.038)*	-0.270 *(0.037)*	-0.001 *(1.468)*	-0.003 *(1.464)*

Table 4: Decomposition of Concentration Indices, Men

	2002			2007		
	Elasticities	**Conc Index**	**Contri-bution**	**Elasticities**	**Conc Index**	**Contri-bution**
Age	4.3046	-0.2339	-1.0069	4.4370	-0.2006	-0.8900
Age^2	-2.3567	-0.4542	1.0704	-2.4460	-0.4095	1.0017
Health	-0.9089	0.1598	-0.1452	-0.7883	0.1686	-0.1329
Smoker	-0.0702	-0.2747	0.0193	-0.0296	-0.2554	0.0076
Inter	-0.0110	-0.6331	0.0070	0.0137	-0.5352	-0.0073
Leaving	-0.0255	0.3096	-0.0079	-0.0182	0.0423	-0.0008
3rd Level	-0.1744	1.3746	-0.2398	-0.1241	1.1471	-0.1424
Married	0.0302	0.0973	0.0029	0.1131	0.1871	0.0211
Widowed	0.0001	-1.0498	-0.0001	-0.0086	-0.9974	0.0086
Sep/Div	0.0140	-0.4451	-0.0062	-0.0002	-0.1104	0
Home D	0.0046	-0.2121	-0.0010	-0.0051	-1.7786	0.0091
Unemp	-0.0143	-2.1730	0.0311	0.0031	-2.1859	-0.0069
Retired	-0.0061	-1.0490	0.0064	-0.0043	-1.1911	0.0052
Student	-0.0046	0.0376	-0.0002	-0.0072	-1.0032	0.0072
Sick	-0.0063	-2.1920	0.0138	-0.0063	-2.4572	0.0156
Other	0.0060	-1.3848	-0.0083	-0.0021	-1.2223	0.0025
Equiv Y	-0.0145	1.4746	-0.0213	-0.0486	1.1933	-0.0579
Residual			-0.0103			-0.0249
Total			**-0.2963**			**-0.1845**

Table 5: Decomposition of Concentration Indices, Women

	2002			2007		
	Elasticities	**Conc Index**	**Contri-bution**	**Elasticities**	**Conc Index**	**Contri-bution**
Age	3.2417	-0.1816	-0.5888	4.6007	-0.1406	-0.6468
Age^2	-1.7757	-0.3875	0.6880	-2.5555	-0.308	0.7891
Health	-1.6231	0.1542	-0.2502	-0.9339	0.1635	-0.1527
Smoker	-0.0459	-0.4998	0.0230	-0.0578	-0.5533	0.0320
Inter	-0.0287	-1.0745	0.0309	-0.0283	-0.9736	0.0276
Leaving	-0.1274	-0.0292	0.0037	-0.1088	0.0177	-0.0019
3rd Level	-0.1940	1.2262	-0.2379	-0.2075	1.0438	-0.2166
Married	0.0172	0.2607	0.0045	0.0146	0.3996	0.0058
Widowed	-0.0168	-1.4588	0.0245	-0.0182	-1.1656	0.0212
Sep/Div	0.0058	-1.4275	-0.0084	-0.0064	-0.9514	0.0061
Home D	0.0411	-0.9570	-0.0394	0.0016	-0.8188	-0.0013
Unemp	0.0164	-1.3208	-0.0217	-0.0015	-2.0154	0.0030
Retired	-0.0130	-0.9525	0.0123	-0.0093	-0.9880	0.0092
Student	-0.0014	-0.5890	0.0008	0.0024	-0.7389	-0.0017
Sick	-0.0034	-1.9780	0.0067	0.0100	-1.2613	-0.0126
Other	0.0072	0.1425	0.0010	0.0036	-0.8855	-0.0031
Equiv Y	-0.1102	1.4561	-0.1605	-0.1252	1.2223	-0.1531
Residual			-0.0846			0.0198
Total			**-0.5961**			**-0.2760**

Table 6: Change in Concentration Indices, 2002-2007

	Men		Women	
	Change arising from change in		Change arising from change in	
	Elasticities	Conc Index	Elasticities	Conc Index
Age	-0.0301	0.1478	-0.2469	0.1889
Age^2	0.0405	-0.1093	0.3021	-0.2010
Health	0.0193	-0.0070	0.1062	-0.0087
Smoker	-0.0111	-0.0006	0.0059	0.0031
Inter	-0.0156	0.0013	-0.0004	-0.0029
Leaving	0.0023	0.0049	-0.0005	-0.0051
3rd Level	0.0691	0.0282	-0.0165	0.0378
Married	0.0082	0.0101	-0.0007	0.0020
Widowed	0.0092	-0.0004	0.0020	-0.0053
Sep/Div	0.0063	-0.0001	0.0175	-0.0030
Home D	0.0021	0.0080	0.0379	0.0002
Unemp	-0.0379	0	0.0236	0.0010
Retired	-0.0019	0.0006	-0.0034	0.0003
Student	-0.0001	0.0075	-0.0022	-0.0004
Sick	0.0001	0.0017	-0.0265	0.0072
Other	0.0111	-0.0003	-0.0005	-0.0037
Equiv Y	-0.0503	0.0137	-0.0218	0.0293
Sub-Total	**0.0202**	**0.1061**	**0.1757**	**0.0399**
%	**18.1**	**94.9**	**54.9**	**12.5**
Residual	**-0.0145 (-13.0%)**		**0.1045 (32.6%)**	
Total Change	**0.1118**		**0.3201**	