UCD CENTRE FOR ECONOMIC RESEARCH

WORKING PAPER SERIES

2016

Child and Adolescent Obesity in Ireland: A Longitudinal Perspective

David Madden, University College Dublin

WP16/06

August 2016

UCD SCHOOL OF ECONOMICS
UNIVERSITY COLLEGE DUBLIN
BELFIELD DUBLIN 4

Child and Adolescent Obesity in Ireland: A Longitudinal Perspective

David Madden

(University College Dublin)

July 2016

Abstract: This paper examines developments in childhood and adolescent obesity in Ireland using two waves of the Growing Up in Ireland survey. Obesity appears to level off between the two waves though there is tentative evidence that the socioeconomic gradient, measured with respect to maternal education and family income, becomes steeper. Exploiting the longitudinal nature of the data, transitions into and out of obesity are examined, with higher rates of transition into obesity observed for those whose mothers have the lowest level of education. Decomposition of the concentration index with respect to income reveals a greater role for income related obesity mobility rather than obesity related income mobility.

Keywords: Obesity, socioeconomic gradient, longitudinal.

JEL Codes: I12, I14,

Corresponding Author: David Madden,

School of Economics,

University College Dublin,

Belfield,

Dublin 4,

Ireland.

Phone: 353-1-7168396

Fax: 353-1-2830068

E-Mail: david.madden@ucd.ie

I am grateful to John Cullinane and Brendan Walsh for useful comments and discussion. The usual disclaimer applies.

Child and Adolescent Obesity in Ireland: A Longitudinal Perspective

1. Introduction

There has been much concern in recent years about rates of obesity and overweight among children and adolescents, in Ireland and abroad.[1] Ireland for example has seen an ongoing campaign entitled *Let's Take On Childhood Obesity, One Step at a Time*, co-ordinated between *safe*food and the Department of Health, while international concern is reflected in the review by Han et al (2010). There is also evidence that, in some countries at least, rates of obesity may have plateaued (Keane et al, 2014, Olds et al, 2011).

Childhood obesity is a cause for concern as it may be linked to a variety of serious conditions including cardiovascular dysfunction, type 2 diabetes, pulmonary, hepatic, renal and musculoskeletal complications. There are also likely to be adverse effects on health related quality of life and emotional states (Olds et al, 2011). In addition should obesity persevere into adulthood, then there are increased risk factors for further serious conditions.

In this paper we examine the trend in obesity amongst a group of Irish children using a nationally representative data source, *Growing Up in Ireland (GUI).* As GUI follows the same children over time, not only are we able to provide a snapshot of obesity at two different points in time for a cohort of nine year olds and then a cohort of 13 year olds, in addition, since it is the same children in these cohorts, we are able to examine transitions into and out of obesity (and overweight). The availability of longitudinal data implies that instead of merely analysing snapshots at a given point in time, it is also possible attention to examine trajectories of obesity/overweight (for an example with respect to poverty/inequality see Jenkins and van Kerm, 2006, Grimm, 2007). Thus we can examine the extent to which obesity/overweight at this age can be regarded as a chronic condition which persists, or whether there is a degree of "churning" in the sense that children move in and out of states of overweight/obesity.

[1] For the sake of brevity we will use the generic term "children" to indicate anyone aged less than 18, while fully acknowledging that height and weight differ systematically by age. The two waves of data which we will be analysing include children aged 9 and 13, the latter age being more accurately described as early adolescence.

The second issue which we examine in this paper is the socioeconomic gradient of obesity. A notable feature of the prevalence of obesity in many countries is the presence of a socioeconomic gradient (McLaren, 2007) and this applies to both children and adults. Thus obesity tends to be more concentrated amongst groups of lower socioeconomic status (SES) and this appears to be the case for a variety of different measures of SES (for a recent review with respect to children and adolescents, see Chung et al, 2016).

We analyse this socioeconomic gradient with respect to two different indicators of socioeconomic status. Firstly, in terms of our analysis of incidence of obesity and transitions into and out of obesity we examine how these differ according to the education level of the mother. Subsequently we investigate the issue using family income as our measure of SES, employing the standard methodology of concentration indices (for a general introduction to the concentration indices, see Wagstaff and Van Doorslaer, 2000).

Once again, the longitudinal nature of our data permits a richer analysis compared to having simple cross sectional data. As well as providing a snapshot of the gradient at two points in time, given that our data is longitudinal, we observe the *same* cross-section at two different points in time, once when they are aged 9 and again when they are aged 13. Thus we can examine how the gradient changes as children age, controlling for cohort. We can also investigate the interaction between income mobility, health mobility and the gradient. As shown by Allinson et al (2010) changes in the socioeconomic gradient of obesity will reflect developments in income-related health mobility *and* in health-related income mobility. A simple decomposition can evaluate the relative importance of these two factors.

The remainder of the paper is laid out as follows. In section 2 we discuss the measurement of obesity for children and review other work in this area for Ireland. In section 3 we discuss our data and also provide an analysis of obesity using the snapshot method i.e. we treat the data as if it were two cross-sections and do not exploit its panel nature. In section 4 we take account of the panel nature of the data and examine transitions between states of obesity/overweight. In section 5 we outline our approach to measuring the socioeconomic gradient of childhood obesity (and overweight) with respect to income, where we employ the concentration index, also exploiting the longitudinal nature of our data, while section 6 provides concluding comments.

2. The Measurement of Obesity in Children and Adolescents

The most common measure of obesity used for adults is derived from body mass index (BMI). BMI is obtained by dividing weight (in kilos) by height (in metres) squared. The World Health Organisation suggests a threshold BMI of 25 for “overweight”, a threshold of 30 for “obesity” and a threshold of 40 for “severely obese”.

It is worth noting that 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 Burkhauser and Cawley, 2008). However, most of the alternative measures suggested are typically not available in large-scale, nationally representative datasets. Thus we will use BMI as our indicator for obesity in this paper, while bearing in mind that the nature of the analysis presented here could also be applied to alternative measures of obesity.

There is, however, one additional issue which must be taken into account when using BMI to measure obesity in children. While the BMI thresholds for adults have general acceptance and do not differ by age or gender, the same is not true for children, where BMI can change systematically with age and gender. For example, at birth median BMI is around 13, this increases to 17 at age 1, decreases to 15.5 at age 6 and increases to 21 at age 20 (Cole et al, 2000). Cole et al (2000) provide a set of cutoff points for BMI for childhood based upon international data and which they suggest should be used for international comparisons. They obtain these by drawing centile curves which pass through the adult cut-off points at age 18 and which then can be traced back to provide “equivalent” cut-off points for different ages and genders. The cutoffs are obtained by averaging data from large nationally representative surveys from Brazil, Great Britain, Hong Kong, the Netherlands, Singapore and the US, with in total nearly 200,000 observations aged from birth to 25.

The cutoffs are provided at half-yearly intervals. Thus for the first wave of our data, the vast majority of children are aged 9. Assuming that age is distributed uniformly within the cohort of nine year olds, it seems appropriate to take the cut-off for age 9.5. Similarly for the second wave of our data (who are mostly 13 year olds) we use the cut-off for age 13.5. For the very small number of children aged 8 and 10 we use the 8.5 and 10.5 cutoffs respectively and similarly for the second wave we use the 12.5 and 14.5 cut-offs for those aged 12 and 14. The age and gender specific cutoffs are provided in table 1. These cutoffs have also been used in previous studies which have analysed child obesity using GUI e.g. Layte and McCrory (2011).

In the analysis which follows, for the most part we present our results with respect to children who are obese and/or overweight. We do not analyse developments in BMI *below* the obesity/overweight thresholds. While this would be quite straightforward to do using a practically identical approach, we choose not to do so as we believe that from a policy point of view the principle of *focus* applies.[2] Thus policy-makers are primarily concerned with changes in BMI which lead people to move into or out of critical categories such as obesity or overweight. BMI changes away from these critical thresholds are of second-order importance. A similar approach typically applies to the analysis of income poverty, where policy-makers are more concerned with incomes below the poverty line and with mobility across the poverty line, but are less concerned with developments above this line.

We now review some of the evidence concerning childhood obesity in Ireland. Perry et al (2009) showed that weight for children in Ireland had increased disproportionately compared to height, thus leading to a rise in BMI, over the period from the late 1940s to the mid 2000s. Keane et al (2014) provide a comprehensive review of more recent evidence concerning trends and prevalence of primary school aged children in Ireland, covering the period from 2002 to 2012. After carefully reviewing a number of studies, they confined their analysis to 14 studies which met their inclusion criteria. Sample sizes ranged from 204 to 14036 and the setting was either the home or the school. They detected a small significant declining trend in obesity prevalence over time when national and regional studies were combined. However, neither national nor regional studies on their own revealed a declining trend and no trend was evident either in studies of overweight. They also detected a consistently higher prevalence of obesity amongst girls compared to boys. Overall, the study concluded that while rates of childhood obesity and overweight in Ireland were high, they did appear to be stabilizing. While this evidence of stabilisation may offer some reassurance to policy makers, it is still arguable that the level of obesity is unacceptably high. It is also the case that the level of obesity is distinct from its distribution with respect to SES.

[2] We say “practically identical” since analysis of BMI, a continuous variable is slightly different from analysis of binary variables such as obesity or overweight. This is particularly true with respect to the concentration curve analysis in section 4 as we explain in more detail below.

These findings are consistent with results from a number of other developed countries. Olds et al (2011) present evidence from nine countries (Australia, China, England, France, Netherlands, New Zealand, Sweden, Switzerland and the US) suggesting no change in the unweighted average of obesity prevalence in these countries over the period 1995 to 2008. Within this overall average however, rates of change differed by gender, age, socioeconomic status and ethnicity.

Our study builds upon this work. As well as examining obesity and overweight at two snapshot points in time (2007-2008 and 2011-2012), we also look at trajectories over time for the same children. We now discuss our data and present our first results using the snapshot approach.

3. Data and results

Our data comes from the first two waves of the Growing Up in Ireland 9 year old cohort. This tracks the development of a cohort of children born in Ireland in the period November 1997-October 1998 (see Williams et al, 2009). The sampling frame of the data was the national primary school system, with 910 randomly selected schools participating in the study. Weight was measured to the nearest 0.5 kg using a medically approved flat mechanical scales and children were advised to wear light clothing. Height was measured to the nearest mm using a height measuring stick.

In all, the original sample in wave 1 consisted of 8568 children. Observations for where there were not valid height and weight measures were dropped, leaving a sample size of 8136. These children were then re-surveyed at age 13 for the second wave. Since we wish to follow trajectories of BMI over the two waves, we choose to use a balanced panel i.e. only those observations who appear in both waves. This reduces the sample size to 7165. When we once again drop observations where valid height and weight observations are not available the final sample reduces to 6973 (3424 boys and 3549 girls).

In making these adjustments the issue of non-random attrition arises. The greatest “loss” of observations comes when we keep only those children who appear in both waves i.e. the attrition between waves 1 and 2. When allowance is made for families who left Ireland between waves 1 and 2, the attrition rate is less than 10 per cent (see Quail et al, 2014). However, attrition is such surveys is rarely random and this is confirmed in Quail et al (2014) who show that non-response for wave 2 is lower amongst younger and less well educated respondents (note that by "respondents" we are referring to the primary caregiver, almost always the mother). Correspondingly the data was re-weighted so that the weight in wave 2 was the product of the original sampling weight for wave 1 and the attrition weight which took account of non-random attrition. In the analysis which follows it seems most appropriate to use these wave 2 weights as we are only carrying out analysis on the balanced panel i.e. those observations who appear in both waves.

There is one final adjustment we make to the data which facilitates our analysis. As the obesity and overweight thresholds for BMI change (since the sample is now four years older) a simple comparison of BMI can be misleading. Consequently we compare *normalized* BMI figures, where BMI is divided by the appropriate overweight/obesity threshold. Thus for example, suppose we are comparing obesity between the two waves. A normalized BMI of 1.1 indicates that the child had a BMI which was 1.1 times the relevant threshold for their age and gender. This facilitates comparisons across time and gender where these thresholds differ.

In table 2 we present, by gender, the mean values for BMI and for BMI normalized to thresholds for overweight and obesity for waves 1 and 2. The results here confirm the findings in Keane et al (2014). While headline BMI increases for both boys and girls this does not imply that obesity and overweight have risen, since the relevant thresholds also rise! The figures for normalized BMI (relative to the obesity threshold) show that it falls by about 1.5%, though with respect to overweight it is static. The rate of obesity falls slightly, while the rate of overweight rises slightly. Even allowing for different rates of change in the thresholds this suggests some changes in the shape of the distribution, with less weight in the more extreme tail but slightly more between the 75^{th} and 95^{th} percentile and this is reflected in figures 1 and 2 which presents kernel densities for normalized BMI in both waves with respect to obesity and overweight thresholds respectively. However, none of the changes in obesity rates are statistically significant, while only the change in the total overweight rate is significant at 10%.

Gender differences are also apparent, with higher rates of obesity and overweight observed for girls. While the gap in obesity rates between the genders stays pretty much the same between waves 1 and 2, the overweight rates converge somewhat, though the overweight rate for females remains higher.

In tables 3a-3c we present these results (for both genders) by education level of the principal carer. We break down the sample into four education categories: (i) completion of lower secondary schooling (denoted as education level=1) (ii) completion of secondary schooling (education level=2) (iii) obtaining a post secondary school diploma or cert (education level=3) and (iv) completion of third level education (education level=4). As these tables show, a socioeconomic gradient is observable for all measures. For the most part, these differences by maternal education are statistically significant. Tables A1 to A12 show the results for tests of statistical significance, and with the exception of the comparison between education levels 2 and 3, differences are nearly always significant at conventional levels of significance.

Between waves 1 and 2, obesity rates increase for the lowest level of maternal education, fall for the next two levels and then rise marginally for the highest level of maternal education (all of these changes with the exception of the marginal rise for the highest level of maternal education are statistically significant) Overall, this suggests that the socioeconomic gradient of obesity (by maternal education) has risen slightly between waves 1 and 2 (we investigate this more further, though with respect to income, in section 5).

For the most part the changes from wave to wave are not statistically significant when broken down by gender, presumably reflecting the smaller sample sizes. Perhaps the most notable exception here is the fall in obesity for girls whose mothers have secondary school education.

However, as explained above, the analysis so far has been carried out on an anonymised basis. We now turn to examine the data on a non-anonymised basis. In this case we are not so much interested in levels of BMI or normalised BMI across the waves as in the trajectories of individuals between wave 1 and wave 2. In the analysis which follows we will examine transitions into and out of obesity and overweight between the two waves.

4. Transitions Into and Out of Obesity/Overweight

We start off with some summary statistics. In tables 4a-4c we look at a transition matrix of normalised BMI by quintile (here BMI is normalised by the obesity threshold). Thus for example in table 4a, the top left entry in the matrix is 0.565. This reveals that of the population who were originally in the bottom quintile of normalised BMI, just over 56% of them stayed in this quintile. 28% moved up to the next highest quintile, while 2.8% moved all the way up to the highest quintile. A lack of mobility is reflected in high values along the main diagonal, indicating that most people stayed in the same quintile. Thus a summary measure of mobility which has been suggested by Shorrocks (1978) is $\frac{m - Tr(M)}{m-1}$ where *m* refers to the dimensionality of the transition matrix (5, in this case) and *Tr(M)* is the trace of the transition matrix, *M*. Calculation of this measure for the transition matrices in tables 4a-4c show very little variation (values of 0.581, 0.584 and 0.578 respectively), indicating that mobility across the overall distribution of BMI shows little variation by gender.

While these indicators of mobility in BMI are of interest, given the focus on obesity in this paper, we may be more concerned with transitions above and below the relevant obesity thresholds, rather than between quantiles. Thus a *mobility matrix* which examines movements across these thresholds may be more relevant than the transition matrices in table 4. These matrices are presented in tables 5, 6 and 7 and the summary measures of mobility are in table 8. The data in tables 5, 6 and 7 are presented as "row proportions". Thus if we look at table 5a, which gives this information for the sample as a whole, the first two entries on row 1 are 0.9723 and 0.0277 respectively. What this tells us is that of those who were non-obese in wave 1, 97.23% remained non-obese in wave 2, while 2.77% become obese. The second row tells us that of those who were obese in wave 1, 47.85% become non-obese in wave 2, while 52.15% remain obese.

Note that since overall obesity rates have remained quite stable, this implies that inflows and outflows from obesity approximately balance each other in absolute numbers, and since the obesity rate is low (around 5%), this implies that proportional transitions from obesity will be much higher. Thus for the sample as a whole nearly half of those who are obese in wave 1 make the transition to non-obesity, whereas only just under 3% make the transition in the opposite direction. Thus when interpreting these figures, since absolute numbers of obese adolescents are low, and so too are the numbers transiting, mobility rates (particularly out of obesity) can appear quite high and may suggest greater mobility than is actually the case.

It may still be useful however to look at how these figures differ by gender and by maternal educational level, and also to check the statistical significance of differences in these rates by gender and maternal education (recall maternal education is divided into 4 levels, increasing from level 1 to 4). Tables 5a to 5c show overall results by gender, while tables 6a to 6d show results by maternal education for boys, and tables 7a to 7d show corresponding results for girls.[3] In terms of differences by gender, boys show higher transition rates *out of* obesity than girls. Transition rates into obesity show no statistically significant difference.

Turning now to how mobility differs by education and dealing first of all with boys, tables 6a to 6d suggest a clear social gradient for transitions into obesity, as the rate of transition decreases as maternal education increases. Thus 5.26% of boys whose mothers have the lowest level of education (level 1) become obese between waves 1 and 2, whereas this is the case for less than 1% of boys whose mothers have the highest level of education (level 4). Tests for statistical significance indicate that boys with the lowest level of maternal education are the outliers here. There is no statistically significant difference between maternal levels 2 and 3, or between levels 3 and 4 for transitions into obesity. In terms of transitions *out of* obesity, transition rates are generally lower for boys with higher maternal education, but none of these differences are statistically significant.

Turning now to girls, once again there is a social gradient and once again it manifests itself via a higher rate of transition into obesity for those with the lowest level of maternal education, and this difference is statistically significant. While there are slight differences between girls with other levels of maternal education, the differences are not statistically significant. The pattern for transitions *out of* obesity is a little more complex. The transition rates out of obesity are lowest for those with levels 1 and 4 of maternal education. However, the difference is only statistically significant for comparisons between level 1 and levels 2 and 3.

We also present results for transitions between overweight and non-overweight and thus tables 9-11 are the analogues of tables 5-7 and table 8 shows the summary mobility statistics by gender and educational level of the mother (we do not present the analogue of tables 4a-4c here since quintiles of BMI normalised by overweight thresholds will be identical to those normalised by obesity). In general there are more transitions, as might be expected since, given that the thresholds are further "down" the distribution, there is a greater mass of observations that can potentially make the transition.

Overall, there appears to be less evidence of a social gradient for these transitions. For boys, the highest rate of transition into overweight is observed for boys with lowest maternal

[3] Tables A14 to A25 show p-values for tests of statistical significance for differences in the transition rates into and out of obesity by gender and by maternal education.

education, but the difference is statistically significant only with regard to education level 3. For transitions out of overweight, the lowest rate is observed for education level 2, and it is statistically significantly different from levels 3 and 4.

For girls, the rate of transition into overweight is highest for maternal education level 1 and lowest for maternal education level 4, and these rates are statistically significantly different from levels 2 and 3 (and *a fortiori* from each other). There are no statistically significant differences by maternal education in transitions out of overweight.

Overall, when we combine the evidence for transitions with the evidence for the incidence of obesity, there is evidence of a maternal education gradient, especially with respect to those who have the lowest level of maternal education. The gap between obesity and overweight for this group with respect to other groups has widened and in a number of cases the widening is statistically significant. In terms of transitions it also appears to be the case that in general this group shows the highest transitions into and (to a lesser extent) the lowest transitions out of obesity/overweight. A continuation of these trends could see quite a wide gap open up between this group and the rest of the population. This also implies a pattern of multiple deprivation for these children, as there is also evidence that they have the poorest educational achievements (Madden, 2014).

Thus, as we have seen in the analysis so far, there appears to be some evidence of a socioeconomic gradient with respect to the incidence of obesity/overweight and also with regard to transitions, when maternal education is used as the measure of socioeconomic status. In the next section we investigate whether this also holds true when family income is used as the measure of socioeconomic status and here we investigate this issue employing standard statistical techniques from health economics.

5. The socioeconomic gradient of obesity: a more formal approach

We employ the standard methodology of the concentration index to explore the socioeconomic gradient of obesity (we also measure the gradient with respect to being overweight, but since the formal analysis is identical we confine this section to outlining measurement issues with respect to obesity). This has been used to study the socioeconomic gradient of obesity amongst adults in Ireland (Madden, 2013) and has been employed in many other studies examining the association between the incidence of a particular health condition and a measure of socioeconomic status (see Kakwani et al, 1997).

Suppose we have a cardinal 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). If a higher value of h_i is 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.

The analysis above refers to the situation where the health variable is continuous and cardinal. When looking at the concentration index for a variable such as BMI, this approach is appropriate. However, in the case of the incidence of obesity/overweight h_i is a bounded binary variable which takes on values of 0 or 1. In this case a normalisation must be applied to the concentration index (otherwise the bounds of *C* would not be -1 and +1). Wagstaff (2005) suggested a normalisation of $W = C/(1-\mu_h)$, while in a recent contribution Erregeyers (2009) suggested that the appropriate normalisation be $E = 4\mu_h C = 4\mu_h(1-\mu_h)C_n$. A comprehensive discussion of these issues is provided in Erreygers and van Ourti (2011). In our analysis here we will apply the Erregeyers normalisation to the standard concentration index.

The above analysis refers to the case of a single cross-section. However, we might also have information on how the socioeconomic gradient develops over time. Allanson et al (2010) provide a simple decomposition of the change in the gradient. Suppose we have two periods, a start period, *s*, and a final period, *f*. The change in the Erreyegers version of the concentration index can then be expressed as:

$$E^f - E^s = (E^f - E^{fs}) + (E^{fs} - E^s) = M^R - M^H .$$

Here E^f and E^s refer to the Erreyegers index for the final and start period respectively, while E^{fs} is the value of the index when obesity in the final period is ranked by income in the initial period.

The index M^R $(= E^f - E^{fs})$ reflects health-related income mobility. This measures the change in the Erreyegers index arising from income mobility i.e. changes in the ranking by income between start and final period, holding final health constant. If there is no correlation between final period obesity and changes in income rank, then M^R will equal zero. However it may be plausible that those have higher obesity in wave 2 are more likely to be those whose rank in the income distribution fell between waves 1 and 2. Bearing in mind that if obesity is typically more concentrated amongst lower-income groups, then we anticipate that in general $E^{ij}<0$ (i, $j=f$, s). Thus the absolute value of E^f will exceed that of E^{fs}, and thus would imply $M^R<0$.

The term M^H $(= E^s - E^{fs})$ reflects income-related health mobility. It indicates the change in health between start and finish period keeping income ranks as they were in the start period. If those who are lower ranked in income in the start period are more likely to see a rise in obesity (or those who are higher ranked in income see a fall in obesity), this implies that E^{fs} will have a more negative value than E^s and so M^H will be positive.[4]

Before presenting results, we explain our choice of ranking variable. We use as our ranking variable a measure of equivalised family income. This figure is derived from a sequence of questions on family net household income (i.e. income from all sources after deductions for tax, social insurance and all other levies have been made). This is then equivalised via an adjustment for size and composition, with a weight of 1.0 for the first adult, 0.66 for subsequent adults (i.e. aged >14) and 0.33 for children (aged <14). In wave 1 an actual figure for equivalised income is given. In wave 2 it is provided in bands of €1000, ranging from less than €5000 to greater than €60000, giving 55 different values. Calculating a concentration index from banded income figures is not problematic, particularly when there are as many intervals as here. However, given that we do not pick up a gradient *within* each band of income, the value for the index will be biased downwards slightly. Thus the values of the index calculated for wave 2 can be regarded as a lower bound of the "true" index.

[4] Allanson et al (2010) provide a further decomposition of the M^H term into what they label a progressivity and scale effect. However this decomposition is less useful when dealing with a bounded, binary variable such as obesity.

In table 12 we present the value of the Erreygers concentration index for normalised obesity and overweight by wave and by gender. The results in table 12 treat the two waves as simple cross-sections and we do not exploit the longitudinal nature of the data. We see that for boys there is no statistically significant gradient, with the exception of obesity in wave 2. We observe statistically significant gradients for girls for obesity and for overweight. In all three cases the gradient increases between waves 1 and 2, and in the case of obesity and overweight it increases by a factor of over one half. However, these increases are generally not statistically significant, as shown by the bottom two rows of table 12 which show the p-values for the null hypothesis of no difference in obesity/overweight between waves 1 and 2. Only in the case of obesity for the complete sample is there a change which is statistically significant at conventional levels. In the case of obesity for boys and overweight for girls the significance level is marginal. Thus we can say while the evidence for an increase in the gradient is suggestive, it is not conclusive.

Table 13 presents the Allanson et al decomposition of the change in the concentration index, which enables us to investigate more closely what is driving the change in the concentration indices. As we have seen from table 12 in most cases the change is not statistically significant. But the precise factor lying behind this appears to be the M^R term. In all cases its contribution to the change in the concentration index is about one third of that of M^H , and in no case is the M^R term statistically significant. In contrast, the M^H term is statistically significant in four of the six cases examined here.

Thus in terms of influencing the change in the socioeconomic gradient over time, income-related health mobility is of greater importance than health-related income mobility. In general the absolute value of M^H exceeds M^R by a factor of 3 and it is also statistically significant in most cases. Health related income mobility appears to be of little importance here. A possible explanation for this lies in the fact that in our particular application here, income is measured on a family basis while health is measured for a child. The M^R term will be driven by poor health being associated with downward income mobility. However it seems less likely that a child’s obesity/overweight could adversely affect family income mobility compared to the health of an adult (and presumably bread-winner).

On the other hand, it seems more plausible that lack of resources could be associated with downward health mobility of family members as the family does not have sufficient resources to purchase good quality food or afford leisure and exercise. Thus for the particular application under analysis here, it seems reasonable that income related health mobility would be of greater importance than health related income mobility.

Before concluding this section, perhaps it is worth comparing the results on socioeconomic gradient with respect to income with those obtained in sections 3 and 4 with respect to maternal education. Bearing in mind that the measure of socioeconomic status differed, the results are still quite consistent, which is to be expected given the correlation between family income and maternal education. The figures for incidence of obesity/overweight in sections 3 and 4 appear to show a mild gradient with respect to maternal education and the same could be said regarding transitions into and out of obesity/overweight. This is consistent with the values for the concentration index obtained in section 5. However, the number of transitions into and out of obesity in general terms was quite low, although they did seem to lead to a greater gradient with respect to maternal education. In turn this seems to be quite consistent with the analysis on the change in the concentration index and on mobility in section 5. These figures showed limited, but not conclusive evidence of an increase in the gradient between the two waves and that what increase had occurred was down to income-related health mobility, as opposed to health-related income mobility.

5. Summary and Conclusions

This paper has analysed recent developments in child/adolescent obesity in Ireland using waves 1 and 2 of the Growing Up in Ireland survey. As well as examining the incidence of obesity and overweight for the two waves, transitions into and out of obesity and overweight are also examined. In addition, the socioeconomic gradient of obesity (with respect to maternal education and family income) is also analysed.

Overall, the results suggest that rates of obesity and overweight have levelled off, bearing in mind the different BMI thresholds used for differing age and genders. A socioeconomic gradient with respect to both maternal education and income is evident for both waves. There is tentative evidence that this gradient may have steepened between waves 1 and 2, but the evidence is not clearcut. Transitions into and out of obesity/overweight have generally been such as to widen the gap between those with the lowest level of maternal education and the rest of the population. When the socioeconomic gradient is measured with respect to income, the gradient appears to increase between waves 1 and 2 and the change is on the borderline of conventional levels of statistical significance.

Further analysis of the gradient with respect to income, which exploits the longitudinal nature of the data, indicates that the tentative increase in the gradient was down to income related health mobility i.e. those whose (family) income levels were low experienced a deterioration in obesity/overweight. Health-related income mobility i.e. where those who were obese/overweight experience a fall in their family income does not appear to be a major factor, presumably reflecting the fact that child/adolescent health has limited impact upon family income.

Table 1: Age and Gender Specific Cutoffs for Overweight and Obesity from Cole et al

	Male		Female	
Age	**Overweight**	**Obese**	**Overweight**	**Obese**
8.5	18.76	22.17	18.69	22.18
9.5	19.46	23.39	19.45	23.46
10.5	20.20	24.57	20.29	24.77
12.5	21.56	26.43	22.14	27.24
13.5	22.27	27.25	22.98	28.20
14.5	22.96	27.98	23.66	28.87

Table 2: BMI and Normalised BMI by gender, waves 1 & 2 (standard errors in brackets).

	Boys		Girls		Overall	
	Wave 1	**Wave 2**	**Wave 1**	**Wave 2**	**Wave 1**	**Wave 2**
BMI	17.68 (0.06)	20.218 (0.07)	18.09 (0.08)	21.42 (0.094)	17.88 (0.05)	20.80 (0.06)
BMIOB	0.76 (0.003)	0.74 (0.003)	0.77 (0.003)	0.76 (0.003)	0.76 (0.002)	0.75 (0.002)
BMIOV	0.91 (0.003)	0.91 (0.003)	0.93 (0.004)	0.93 (0.004)	0.92 (0.003)	0.92 (0.003)
Obesity Rate	0.047 (0.004)	0.043 (0.004)	0.072 (0.006)	0.071 (0.006)	0.059 (0.004)	0.057 (0.004)
Overweight Rate	0.212 (0.009)	0.227* (0.010)	0.298 (0.011)	0.290 (0.011)	0.254 (0.007)	0.257 (0.007)

***, **, * indicates change from previous wave is significant at 1%, 5% and 10% levels respectively.

Table 3a: BMI and Normalised BMI by education of principal carer, waves 1 & 2 (standard errors in brackets).

	Lower Sec		**Secondary**		**Dip/Cert**		**3rd Level**	
	W1	**W2**	**W1**	**W2**	**W1**	**W2**	**W1**	**W2**
BMI	18.27 (0.12)	21.49 (0.15)	17.86 (0.08)	20.70 (0.09)	17.75 (0.10)	20.51 (0.11)	17.34 (0.09)	20.13 (0.10)
BMINORMOB	0.78 (0.005)	0.77 (0.005)	0.76 (0.003)	0.75 (0.003)	0.76 (0.004)	0.74 (0.004)	0.74 (0.004)	0.73 (0.004)
BMINORMOV	0.94 (0.006)	0.95 (0.006)	0.92 (0.004)	0.92 (0.004)	0.91 (0.005)	0.91 (0.005)	0.89 (0.005)	0.89 (0.004)
Obesity	0.085 (0.009)	0.102* (0.01)	0.056 (0.006)	0.040** (0.004)	0.056 (0.009)	0.043* (0.007)	0.025 (0.005)	0.028 (0.004)
Overweight	0.300 (0.016)	0.320 (0.016)	0.255 (0.012)	0.257 (0.002)	0.237 (0.014)	0.222 (0.013)	0.189 (0.014)	0.183 (0.014)

***, **, * indicates change from previous wave is significant at 1%, 5% and 10% levels respectively.

.

Table 3b: BMI and Normalised BMI by education of principal carer, waves 1 & 2 (standard errors in brackets) - Boys.

	Lower Sec		**Secondary**		**Dip/Cert**		**3rd Level**	
	W1	**W2**	**W1**	**W2**	**W1**	**W2**	**W1**	**W2**
BMI	17.751 (0.154)	20.450 (0.181)	17.786 (0.095)	20.298 (0.119)	17.686 (0.139)	20.010 (0.141)	17.350 (0.010)	19.814 (0.128)
BMINORMOB	0.759 (0.006)	0.750 (0.007)	0.760 (0.004)	0.745 (0.004)	0.756 (0.006)	0.737 (0.005)	0.742 (0.004)	0.727 (0.005)
BMINORMOV	0.912 (0.008)	0.918 (0.008)	0.914 (0.005)	0.911 (0.005)	0.909 (0.007)	0.902 (0.006)	0.891 (0.005)	0.890 (0.006)
Obesity	0.062 (0.010)	0.074 (0.012)	0.046 (0.007)	0.037 (0.006)	0.053 (0.012)	0.036 (0.007)	0.018 (0.004)	0.018 (0.004)
Overweight	0.223 (0.020)	0.257* (0.022)	0.229 (0.015)	0.247 (0.016)	0.206 (0.018)	0.188 (0.018)	0.168 (0.017)	0.179 (0.019)

***, **, * indicates change from previous wave is significant at 1%, 5% and 10% levels respectively.

Table 3c: BMI and Normalised BMI by education of principal carer, waves 1 & 2 (standard errors in brackets) - Girls

	Lower Sec		**Secondary**		**Dip/Cert**		**3rd Level**	
	W1	**W2**	**W1**	**W2**	**W1**	**W2**	**W1**	**W2**
BMI	18.740 (0.159)	22.414 (0.214)	17.939 (0.121)	21.146 (0.133)	17.836 (0.143)	20.990 (0.180)	17.431 (0.163)	20.493 (0.157)
BMINORMOB	0.799 (0.007)	0.794 (0.008)	0.764 (0.005)	0.750 (0.005)	0.760 (0.006)	0.744 (0.006)	0.742 (0.007)	0.727 (0.006)
BMINORMOV	0.964 (0.008)	0.975 (0.009)	0.922 (0.006)	0.920 (0.006)	0.917 (0.007)	0.913 (0.008)	0.896 (0.008)	0.892 (0.007)
Obesity	0.105 (0.015)	0.127 (0.017)	0.066 (0.011)	0.044** (0.007)	0.060 (0.012)	0.052 (0.011)	0.033 (0.009)	0.041 (0.008)
Overweight	0.369 (0.023)	0.377 (0.023)	0.283 (0.019)	0.268 (0.018)	0.274 (0.021)	0.262 (0.021)	0.213 (0.022)	0.188* (0.020)

***, **, * indicates change from previous wave is significant at 1%, 5% and 10% levels respectively.

Table 4a: Transition matrix for normalised BMI by quantile, total sample

Wave 1 Normalised BMI	Wave 2 Normalised BMI						
		1	2	3	4	5	Total
	1	**0.5605**	0.282	0.097	0.046	0.0285	1.0135
	2	0.2775	**0.3395**	0.2425	0.1075	0.0255	0.993
	3	0.119	0.2595	**0.354**	0.2155	0.0495	0.9975
	4	0.0385	0.0975	0.254	**0.3905**	0.2175	0.998
	5	0.009	0.02	0.05	0.241	**0.679**	0.9985
	Total	1.004	0.9985	0.9975	1.001	0.999	5

Table 4b: Transition matrix for normalised BMI by quantile, boys only

Wave 1 Normalised BMI	Wave 2 Normalised BMI						
		1	2	3	4	5	Total
	1	**0.6095**	0.2545	0.0845	0.031	0.0245	1.0035
	2	0.2285	**0.368**	0.2375	0.125	0.041	1
	3	0.112	0.261	**0.36**	0.2185	0.0615	1.0125
	4	0.0425	0.102	0.262	**0.388**	0.198	0.9925
	5	0.009	0.02	0.051	0.2395	**0.6715**	0.9915
	Total	1.0015	1.006	0.995	1.0015	0.9965	5

Table 4c: Transition matrix for normalised BMI by quantile, girls only

Wave 1 Normalised BMI	Wave 2 Normalised BMI						
		1	2	3	4	5	Total
	1	**0.531**	0.2845	0.1135	0.0405	0.034	1.0035
	2	0.3105	**0.346**	0.256	0.1025	0.014	1.0295
	3	0.1305	0.2415	**0.323**	0.22	0.0535	0.969
	4	0.0315	0.1025	0.2575	**0.391**	0.2185	1.0005
	5	0.00455	0.0205	0.0565	0.2415	**0.675**	0.998
	Total	1.008	0.9945	1.0065	0.995	0.996	5

Table 5a: Proportional Obesity Transitions (proportions by status in wave 1)

Total

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9723	0.0277	1
Obese	0.4785	0.5215	1
Total	0.9432	0.0568	1

Table 5b: Proportional Obesity Transitions (proportions by status in wave 1)

Boys Only

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9751	0.0249	1
Obese	0.5797	0.4203	1
Total	0.9567	0.0433	1

Table 5c: Proportional Obesity Transitions (proportions by status in wave 1)

Girls Only

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9693	0.0307	1
Obese	0.4097	0.5903	1
Total	0.929	0.071	1

Table 6a: Proportional Obesity Transitions (proportions by status in wave 1)
Boys, Maternal education level 1

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9474	0.0526	1
Obese	0.6057	0.3943	1
Total	0.9263	0.0737	1

Table 6b: Proportional Obesity Transitions (proportions by status in wave 1)
Boys, maternal education level 2

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9808	0.0192	1
Obese	0.6014	0.3986	1
Total	0.9631	0.0369	1

Table 6c: Proportional Obesity Transitions (proportions by status in wave 1)
Boys, maternal education level 3

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9879	0.0121	1
Obese	0.5296	0.4704	1
Total	0.964	0.036	1

Table 6d: Proportional Obesity Transitions (proportions by status in wave 1)
Boys, maternal education level 4

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9915	0.0085	1
Obese	0.4685	0.5315	1
Total	0.9819	0.0181	1

Table 7a: Proportional Obesity Transitions (proportions by status in wave 1)
Girls, Maternal education level 1

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9435	0.0565	1
Obese	0.2737	0.7263	1
Total	0.8731	0.1269	1

Table 7b: Proportional Obesity Transitions (proportions by status in wave 1)
Girls, maternal education level 2

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9815	0.0185	1
Obese	0.5868	0.4132	1
Total	0.9557	0.0443	1

Table 7c: Proportional Obesity Transitions (proportions by status in wave 1)
Girls, maternal education level 3

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9795	0.0205	1
Obese	0.4697	0.5303	1
Total	0.9484	0.0516	1

Table 7d: Proportional Obesity Transitions (proportions by status in wave 1)
Girls, maternal education level 4

Wave 1	Wave 2		Total
	Non-obese	Obese	
Non-obese	0.9798	0.0202	1
Obese	0.3597	0.6403	1
Total	0.9594	0.0406	1

Table 8: Summary Measures of Obesity Mobility, by Gender and Maternal Education

	Boys		Girls	
	Obesity	**Overweight**	**Obesity**	**Overweight**
Maternal Educ Level 1	1.0868	1.1569	1.0794	1.1826
Maternal Educ Level 2	1.0463	1.1355	1.0556	1.1578
Maternal Educ Level 3	1.0390	1.1311	1.0479	1.1612
Maternal Educ Level 4	1.0170	1.1375	1.0314	1.1172

Table 9a: Proportional Overweight Transitions (proportions by status in wave 1) Total

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.8973	0.1027	1
Obese	0.2889	0.7111	1
Total	0.7428	0.2572	1

Table 9b: Proportional Overweight Transitions (proportions by status in wave 1) Boys Only

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.9014	0.0986	1
Obese	0.2978	0.7022	1
Total	0.7732	0.2268	1

Table 9c: Proportional Overweight Transitions (proportions by status in wave 1) Girls Only

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.8925	0.1075	1
Obese	0.2822	0.7178	1
Total	0.7107	0.2893	1

Table 10a: Proportional Overweight Transitions (proportions by status in wave 1) Boys, Maternal education level 1

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.8779	0.1221	1
Obese	0.2786	0.7214	1
Total	0.7447	0.2553	1

Table 10b: Proportional Overweight Transitions (proportions by status in wave 1) Boys, maternal education level 2

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.9005	0.0995	1
Obese	0.2557	0.7443	1
Total	0.7522	0.2478	1

Table 10c: Proportional Overweight Transitions (proportions by status in wave 1) Boys, maternal education level 3

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.9293	0.0707	1
Obese	0.3656	0.6344	1
Total	0.8138	0.1862	1

Table 10d: Proportional Overweight Transitions (proportions by status in wave 1) Boys, maternal education level 4

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.9108	0.0892	1
Obese	0.3774	0.6226	1
Total	0.8214	0.1786	1

Table 11a: Proportional Overweight Transitions (proportions by status in wave 1) Girls, Maternal education level 1

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.8484	0.1516	1
Obese	0.2353	0.7647	1
Total	0.6213	0.3787	1

Table 11b: Proportional Overweight Transitions (proportions by status in wave 1) Girls, maternal education level 2

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.9005	0.0995	1
Obese	0.306	0.694	1
Total	0.7327	0.2673	1

Table 11c: Proportional Overweight Transitions (proportions by status in wave 1) Girls, maternal education level 3

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.8965	0.1035	1
Obese	0.3131	0.6869	1
Total	0.736	0.264	1

Table 11d: Proportional Overweight Transitions (proportions by status in wave 1) Girls, maternal education level 4

Wave 1	Wave 2		Total
	Non-overweight	Overweight	
Non-obese	0.9411	0.0589	1
Obese	0.3323	0.6677	1
Total	0.8113	0.1887	1

Table 12: Concentration Indices for BMI, Obesity and Overweight by gender, waves 1 & 2 (standard errors in brackets) – Ranking variable, Equivalised Income.

	Boys		**Girls**		**Overall**	
	Wave 1	**Wave 2**	**Wave 1**	**Wave 2**	**Wave 1**	**Wave 2**
Obesity	-.0056 (.0083)	-.0223*** (.0080)	-.0374*** (.0100)	-.0582*** (.0099)	-.0225*** (.0065)	-.0403*** (.0064)
Overweight	.0093 (.0161)	-.0081 (.0165)	-.0733*** (.0177)	-.1122*** (.0175)	-.0362*** (.0120)	-.0603*** (.0121)
P-value (obesity)	0.1111		0.1751		0.0480	
P-value (overweight)	0.7132		0.1070		0.4828	

Table 13: Income-related health mobility and health-related income mobility

	Obesity			**Overweight**		
	Total	**Boys**	**Girls**	**Total**	**Boys**	**Girls**
Wave 1	0.0590	0.0465	0.0720	0.2540	0.2126	0.2976
Wave 2	0.0568	0.0434	0.0709	0.2572	0.2271	0.2889
E^1	-0.0225	-0.0056	-0.0374	-0.0363	0.0093	-0.0733
E^2	-0.0403	-0.0223	-0.0583	-0.0604	-0.0081	-0.1122
E^{21}	-0.0486	-0.0194	-0.0763	-0.0750	-0.0212	-0.1246
ΔE	-0.0178**	-0.0167	-0.0208	-0.0241	-0.0174	-0.0388
M^R	0.0083	-0.0029	0.0181	0.0147	0.0130	0.0123
M^H	0.0261***	0.0137	0.0389***	0.0387*	0.0304	0.0512**

***, **, * indicates significance at 1%, 5% and 10% levels respectively.

Table A1: P-values for test of statistically significant differences by level of maternal education – wave 1 obesity, total sample

Educ=1				
Educ=2	0.0002			
Educ=3	0.0000	0.5207		
Educ=4	0.0000	0.0000	0.0001	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A2: P-values for test of statistically significant differences by level of maternal education – wave 2 obesity, total sample

Educ=1				
Educ=2	0.0000			
Educ=3	0.0000	0.6207		
Educ=4	0.0000	0.0112	0.0515	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A3: P-values for test of statistically significant differences by level of maternal education – wave 1 obesity, boys

Educ=1				
Educ=2	0.0387			
Educ=3	0.0068	0.3970		
Educ=4	0.0000	0.0026	0.0369	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A4: P-values for test of statistically significant differences by level of maternal education – wave 2 obesity, boys

Educ=1				
Educ=2	0.0034			
Educ=3	0.0006	0.4531		
Educ=4	0.0000	0.0074	0.0629	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A5: P-values for test of statistically significant differences by level of maternal education – wave 1 obesity, girls

Educ=1				
Educ=2	0.0019			
Educ=3	0.0029	0.9400		
Educ=4	0.0000	0.0005	0.0010	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A6: P-values for test of statistically significant differences by level of maternal education – wave 2 obesity, girls

Educ=1				
Educ=2	0.0000			
Educ=3	0.0000	0.9684		
Educ=4	0.0000	0.3397	0.3470	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A7: P-values for test of statistically significant differences by level of maternal education – wave 1 overweight, total sample

Educ=1				
Educ=2	0.0002			
Educ=3	0.0001	0.6568		
Educ=4	0.0000	0.0000	0.0001	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A8: P-values for test of statistically significant differences by level of maternal education – wave 2 overweight, total sample

Educ=1				
Educ=2	0.0000			
Educ=3	0.0000	0.0991		
Educ=4	0.0000	0.0000	0.0000	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A9: P-values for test of statistically significant differences by level of maternal education – wave 1 overweight, boys

Educ=1				
Educ=2	0.2823			
Educ=3	0.0611	0.3137		
Educ=4	0.0001	0.0010	0.0313	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A10: P-values for test of statistically significant differences by level of maternal education – wave 2 overweight, boys

Educ=1				
Educ=2	0.1953			
Educ=3	0.0006	0.0093		
Educ=4	0.0000	0.0000	0.0500	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A11: P-values for test of statistically significant differences by level of maternal education – wave 1 overweight, girls

Educ=1				
Educ=2	0.0001			
Educ=3	0.0007	0.6944		
Educ=4	0.0000	0.0010	0.0005	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A12: P-values for test of statistically significant differences by level of maternal education – wave 2 overweight, girls

Educ=1				
Educ=2	0.0000			
Educ=3	0.0001	0.8206		
Educ=4	0.0000	0.0001	0.0001	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A13: P-values for differences by gender for transitions into and out of obesity/overweight

	Obesity	Overweight
Into	0.304	0.435
Out of	0.012	0.611

Table A14: P-values for differences by maternal education for transitions into obesity

Educ=1				
Educ=2	0.000			
Educ=3	0.000	0.513		
Educ=4	0.000	0.237	0.632	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A15: P-values for differences by maternal education for transitions out of obesity

Educ=1				
Educ=2	0.008			
Educ=3	0.244	0.331		
Educ=4	0.905	0.104	0.456	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A16: P-values for differences by maternal education for transitions into overweight

Educ=1				
Educ=2	0.030			
Educ=3	0.004	0.278		
Educ=4	0.001	0.069	0.510	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A17: P-values for differences by maternal education for transitions out of overweight

Educ=1				
Educ=2	0.404			
Educ=3	0.039	0.186		
Educ=4	0.028	0.127	0.748	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A18: P-values for differences by maternal education for transitions into obesity, boys

Educ=1				
Educ=2	0.006			
Educ=3	0.001	0.214		
Educ=4	0.000	0.039	0.420	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A19: P-values for differences by maternal education for transitions out of obesity, boys

Educ=1				
Educ=2	0.969			
Educ=3	0.596	0.596		
Educ=4	0.332	0.318	0.705	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A20: P-values for differences by maternal education for transitions into obesity, girls

Educ=1				
Educ=2	0.004			
Educ=3	0.009	0.776		
Educ=4	0.007	0.800	0.969	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A21: P-values for differences by maternal education for transitions out of obesity, girls

Educ=1				
Educ=2	0.002			
Educ=3	0.099	0.366		
Educ=4	0.616	0.205	0.562	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A22: P-values for differences by maternal education for transitions into overweight, boys

Educ=1				
Educ=2	0.324			
Educ=3	0.028	0.110		
Educ=4	0.193	0.613	0.378	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A23: P-values for differences by maternal education for transitions out of overweight, boys

Educ=1				
Educ=2	0.681			
Educ=3	0.192	0.059		
Educ=4	0.169	0.057	0.873	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A24: P-values for differences by maternal education for transitions into overweight, girls

Educ=1				
Educ=2	0.035			
Educ=3	0.073	0.844		
Educ=4	0.000	0.007	0.016	
	Educ=1	Educ=2	Educ=3	Educ=4

Table A25: P-values for differences by maternal education for transitions out of overweight, girls

Educ=1				
Educ=2	0.186			
Educ=3	0.154	0.904		
Educ=4	0.122	0.694	0.777	
	Educ=1	Educ=2	Educ=3	Educ=4

Figure 1: BMI Normalised to Obesity Threshold

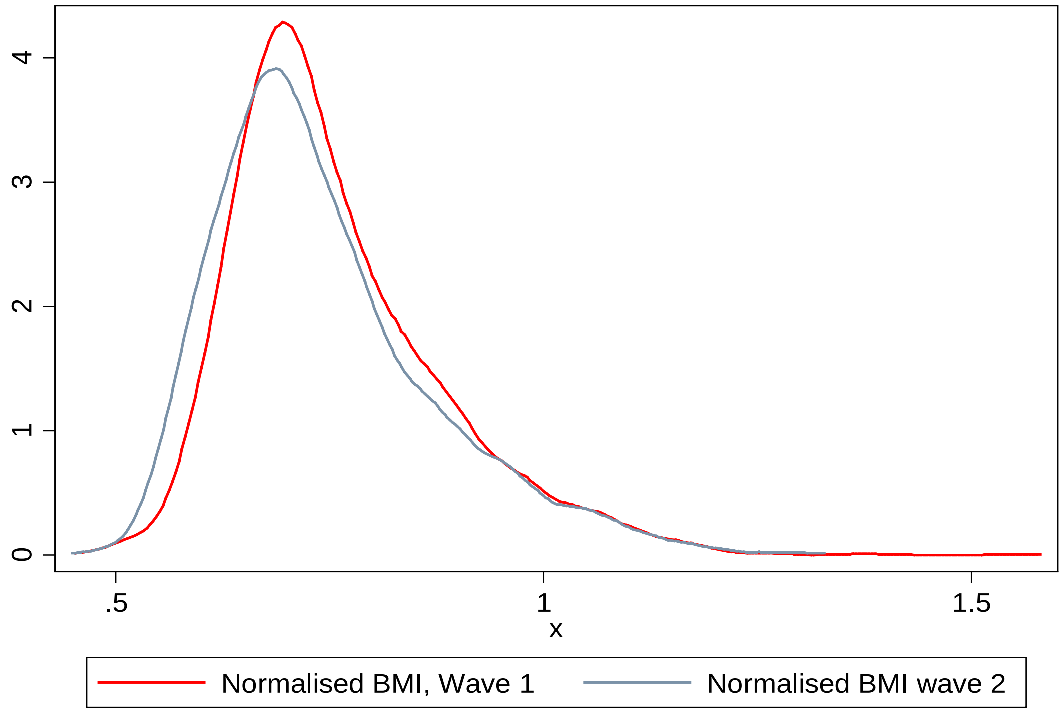
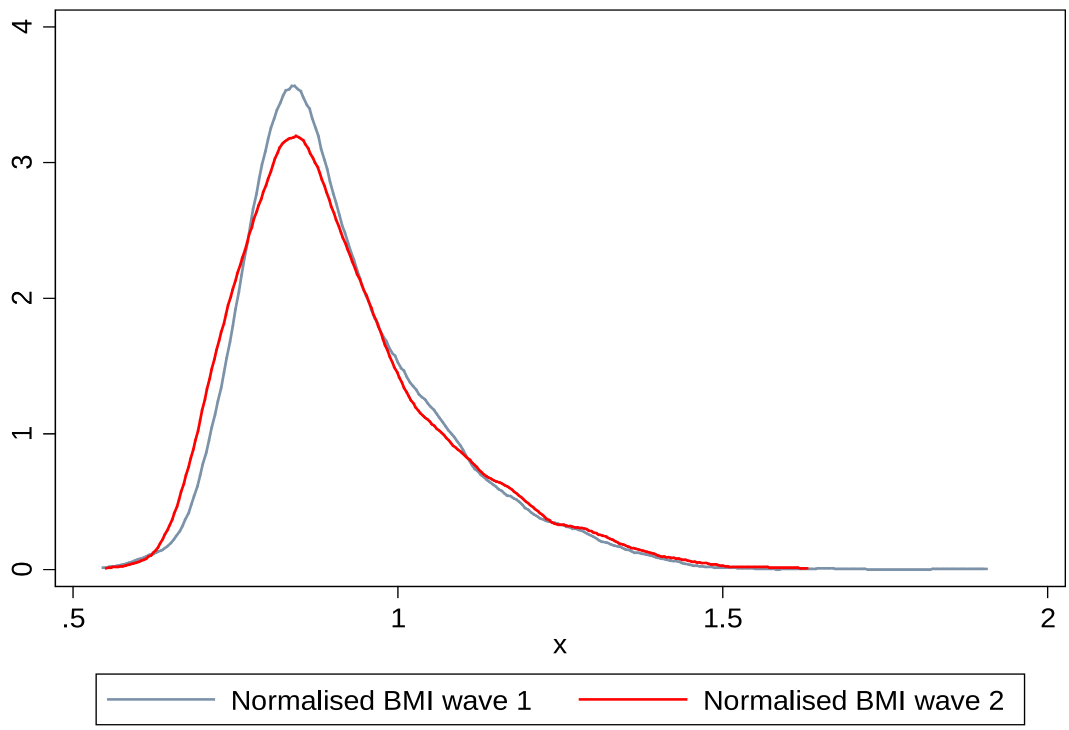


Figure 2: BMI Normalised to Overweight Threshold



References:

Allanson, P., Gerdtham, U. G., & Petrie, D. (2010): Longitudinal analysis of income-related health inequality, *Journal of Health Economics*, Vol. 29, pp.78-86.

Burkhauser, R. And J. Cawley (2008):. Beyond BMI: The value of more accurate measures of fatness and obesity in social science research, *Journal of Health Economics*, vol. 27, pp. 519-529.

Chung., A., K. Backholer, E. Wong, C. Palermo, C. Keeting and A. Peeters (2016): “Trends in Child and Adolescent Obesity Prevalence in Economically Advanced Countries according to Socioeconomic Position: a Systematic Review”, *Obesity Reviews*, Vol. 17, pp. 276-295.

Cole, T., M. Bellizzi, K. Flegal and W. Dietz (2000): Establishing a Standard Definition for Child Overweight and Obesity Worldwide: International Survey, *British Medical Journal*, Vol. 320, pp. 1-6.

Erreygers, G., (2009). “Correcting the Concentration Index”, *Journal of Health Economics*, Vol. 28, pp. 505-515.

Erreygers, G., & Van Ourti, T. (2011). Measuring socioeconomic inequality in health, health care and health financing by means of rank-dependent indices: a recipe for good practice, *Journal of Health economics*, Vol. 30, pp. 685-694.

Grimm, M. (2007): Removing the anonymity axiom in assessing pro-poor growth. *J. Econ. Inequal*. Vol. 5(2), pp. 179–197.

Han, J, D. Lawlor and S. Kimm (2010): Childhood Obesity, *The Lancet*, Vol. 375, no. 9727, pp. 1737-1748.

Jenkins, S., and P. van Kerm (2006): Trends in income inequality, pro-poor income growth and income mobility. *Oxf. Econ. Pap.,* Vol. 58, pp. 531–548.

Kakwani, N., A. Wagstaff and E. Van Doorslaer (1997). “Socioeconomic Inequalities in Health: Measurement, Computation and Statistical Inference”, *Journal of Econometrics*, Vol. 77, pp. 87-103.

Keane, E. , **P. Kearney**, **I. Perry**, **C. Kelleher** and **J.Harrington (2014):** Trends and prevalence of overweight and obesity in primary school aged children in the Republic of Ireland from 2002-2012: a systematic review, *BMC Public Health* , Vol. 14**:** 974.

Layte, R., and C. McCrory (2011): *Obesity and Overweight Among Nine Year Olds*. Government Publications. Dublin.

Madden, D. (2013). The socio-economic gradient of obesity in Ireland. *The Economic and Social Review*, Vol. 44, pp. 181-196.

------------. (2014): “Bridging the Gap: Inequalities in Children’s Educational Outcomes in Ireland”, *UCD School of Economics, Working Paper* WP14/20.

McLaren, L. (2007): “Socioeconomic Status and Obesity”, *Epidemiological Reviews*, Vol. 29, pp. 29-48.

Olds T, Maher C, Zumin S, Péneau S, Lioret S, Castetbon K, Bellisle, de Wilde J, Hohepa M, Maddison R, Lissner L, Sjöberg A, Zimmermann M, Aeberli I,Ogden C, Flegal K, Summerbell C. (2011): Evidence that the prevalence of childhood overweight is plateauing: data from nine countries, *Int J Pediatr Obes.*, Vol. 5-6, pp. 342-60.

Perry, I., H. Whelton, J. Harrington and B. Cousins (2009): The Heights and Weights of Irish Children from the Post-war Era to the Celtic Tiger, *Journal of Epidemiology and Community Health*, Vol. 63, pp. 262-264.

Quail, A., J. Williams, M. Thornton and A. Murray (2014): *A Summary Guide to Wave 2 of the Child Cohort (at 13 Years) of Growing Up in Ireland.* ESRI. Dublin.

Shorrocks, A. (1978): “The Measurement of Mobility.", *Econometrica*, Vol. 46, pp. 1013-24.

Wagstaff, A., (2005). “The bounds of the concentration index when the variable of interest is binary, with an application to immunisation inequality”, *Health Economics*, Vol. 14, pp. 429-432.

Wagstaff, A., and E. Van Doorslaer (2000): “Equity in Health Care Finance and Delivery”, in Culyer, AJ., and JP Newhouse (Eds), *Handbook of Health Economics*, North-Holland. Amsterdam.

Williams, J., S. Greene, E. Doyle et al (2009): *The Lives of 9 Year Olds: Growing Up in Ireland, National Longitudinal Study of Children (Report 1 of the Child Cohort).* Dublin; The Stationery Office.

UCD CENTRE FOR ECONOMIC RESEARCH – RECENT WORKING PAPERS

WP15/14 Cormac Ó Gráda: ''Cast back into the Dark Ages of Medicine'? The Challenge of Antimicrobial Resistance' May 2015
WP15/15 Sandra E Black, Paul J Devereux and Kjell G Salvanes: "Healthy(?), Wealthy, and Wise - Birth Order and Adult Health" July 2015
WP15/16 Sandra E Black, Paul J Devereux, Petter Lundborg and Kaveh Majlesi: "Poor Little Rich Kids? - The Determinants of the Intergenerational Transmission of Wealth" July 2015
WP15/17 Sandra E Black, Paul J Devereux, Petter Lundborg and Kaveh Majlesi: "On The Origins of Risk-Taking" July 2015
WP15/18 Vincent Hogan and Patrick Massey: 'Teams' Reponses to Changed Incentives: Evidence from Rugby's Six Nations Championship' September 2015
WP15/19 Johannes Becker and Ronald B Davies: 'Learning to Tax - Interjurisdictional Tax Competition under Incomplete Information' October 2015
WP15/20 Anne Haubo Dyhrberg: 'Bitcoin, Gold and the Dollar – a GARCH Volatility Analysis' October 2015
WP15/21 Anne Haubo Dyhrberg: 'Hedging Capabilities of Bitcoin. Is it the virtual gold?' October 2015
WP15/22 Marie Hyland and Stefanie Haller: 'Firm-level Estimates of Fuel Substitution: an Application to Carbon Pricing' October 2015
WP15/23 Roberta Cardani, Alessia Paccagnini and Stefania Villa: 'Forecasting with Instabilities: an Application to DSGE Models with Financial Frictions' October 2015
WP15/24 Morgan Kelly, Joel Mokyr and Cormac Ó Gráda: 'Roots of the Industrial Revolution' October 2015
WP15/25 Ronald B Davies and Arman Mazhikeyev: 'The Glass Border: Gender and Exporting in Developing Countries' November 2015
WP15/26 Ronald B Davies and Neill Killeen: 'Location Decisions of Non-Bank Financial Foreign Direct Investment: Firm-Level Evidence from Europe' November 2015
WP15/27 Johannes Becker and Ronald B Davies: 'Negotiated Transfer Prices' November 2015
WP15/28 Ronald B Davies and Arman Mazhikeyev: 'The Impact of Special Economic Zones on Exporting Behavior' November 2015
WP15/29 Cormac Ó Gráda: 'On Plague in a Time of Ebola' November 2015
WP15/30 Kevin Denny: 'Are the Effects of Height on Well-being a Tall Tale?' December 2015
WP15/31 David Madden: 'Do Schooling Reforms Also Improve Long-Run Health?' December 2015
WP16/01 Ronald B Davies, Michael J Lamla and Marc Schiffbauer: 'Learning or Leaning: Persistent and Transitory Spillovers from FDI' February 2016
WP16/02 Alice Albonico, Alessia Paccagnini and Patrizio Tirelli: 'Great Recession, Slow Recovery and Muted Fiscal Policies in the US' March 2016
WP16/03 Cormac Ó Gráda: '"The Last, the Most Dreadful Resource of Nature": Economic-historical Reflections on Famine' March 2016
WP16/04 Kevin Denny and Cormac Ó Gráda: 'Immigration, Asylum, and Gender: Ireland and Beyond' June 2016
WP16/05 Cormac Ó Gráda: 'What's in an Irish Surname? - Connollys and Others a Century Ago' June 2016

UCD Centre for Economic Research Email economics@ucd.ie