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Of Child Overweight

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Of Child Overweight

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Abstract

We study the association between parental overweight and that of their offspring and explore whether parental influence on their children is *gender assortative* (e.g., maternal effect is more important for daughters). We take advantage of a unique dataset, the Health Survey for England, containing records of clinically measured weight and height of a representative sample of English children and their parents for the period 1996-2009. Our findings are consistent with the existence of strong intergenerational transmission of overweight and obesity from parents to their offspring. The effects are stronger among white children and older parents. However, we only find evidence of gender assortative transmission under some restrictive conditions, namely, we find an increased likelihood of overweight among girls when the mother is obese, and especially when girls are either at school or teenage age.

Keywords: Gender Assortative Parental Transmission, Child Obesity, Child Overweight, Role Models, Inter-generational Transmission.

1. Introduction

The share of overweight children is a growing health and socio-economic concern with far reaching consequences. Estimates from the International Association for the Study of Obesity (EASO) indicate that the rates of overweight (including obesity) children aged 5-17 years in the United Kingdom (UK) are among the highest in Europe. Figure 1 displays an increase in child overweight in England, one of the world countries where child obesity has risen at a faster pace, though we find that the trend tails off around 2005. In addition, Figure 1 shows a higher obesity rate increase between children 11-15 than those of younger though overall trends are comparable.

[Insert Figure 1 about here]

Provided that genetics are unlikely to have changed dramatically over the past thirty years (see Herrera *et al*, 2011 for a review), changes in overweight are likely the result of environmental changes that are still not well understood. Given that children do not make autonomous health and food related choices, one of the most pressing hypotheses underpinning the obesity epidemic lies in the existence of *shifts* in the intergeneration transmission of overweight. That is, if the correlation between parents and children's overweight has changed over time, then it is likely that child specific family environment is responsible for such a change (Anderson *et al,* 2007). Children's caloric intake, dietary habits and level of physical activity are associated with that of their parents' social norms and culture (Anderson and Butcher, 2006). By the time children are three or four years of age, their eating patterns are already sensitive to environmental cues about food intake (Nicklas *et al*, 2001) and role modelling (Richtie *et al*, 2005). However, we still have limited knowledge about how the child specific family environment is transmitted. One of the main hypothesis is whether transmission is assortative by gender.

The main purpose of this paper is to empirically establish the existence of an intergenerational transmission of overweight. We specifically examine the presence of differential maternal and paternal overweight influence across different children's age groups and especially, the presence of some gender assortative transmission. Our main focus in on natural children, and similarly as other studies (Classen and Hokayem 2005, Classen, 2010 and Costa-Font and Gil, 2013), we examine the presence of intergenerational transmission, but for a longer period of time, we can distinguish the specific effects of both parents alongside differential effects across the child's age. Other studies drawing on smaller samples of adopted children find evidence of cultural transmission (Costa-Font *et al*, 2015), but mainly due to sample size restrictions, cannot evaluate age specific effects. Other studies focusing on biological relatives do not find evidence of a strong shared environmental effect, but focus on BMI and do not distinguish the effect of overweight and obesity Cawley and Meyerhoefer, 2012).

We find evidence of gender assortative transmission of both parents overweight among girls, driven primarily by girls in their teens, and some evidence of child age specific gender assortative transmission. We in turn examine a number of mechanisms underlying the associations which can explain the presence of different effects across the child's age such as the child being a single child, the age of the mother or the ethnicity. The remainder of the paper is as follows: next section provides the background literature. Section three reports the data and empirical strategy. Section four provides the results and section five contains our conclusion and discussion.

2. Intergenerational and gender associative transmission

A literature spanning several decades provides some evidence that indicates that the probability of an adolescent to be obese increases when one of the parents becomes obese, and the effect is strengthened when both parents are obese (Coate, 1983; Currie et al, 2007; Hebebrand *et al.,* 2000, Martin 2008; Anderson *et al.*, 2007; Classen and Hokayem (2005). Intergenerational correlations estimate typically range between 0.15 and 0.38 (Ahlburg, 1998, Classen 2010). However, the mechanisms are still largely ignored, and the datasets are limited either by the way they measure overweight (self-reported vs clinically measured), the sample size and time span as well as the information available for both parents.

Central to our explanation is the role modelling effects parents exert (the 'like begets likes') which could be driven by effects on eating behaviours (e.g., size portions, time of sugar intakes, regularity of fat intake etc) and fitness behaviour. However, both parents play a potentially different 'gender roles', which paves the way to some form of 'gender assortative' transmission. Consistently, some work points to a stronger maternal effect (Pareo *et al*, 2013). However, part of that effect might be driven the presence of assortative mating. That is, individuals with similar genotypes and/or phenotypes (e.g., body size, cognitive abilities, age, education etc) being more likely to mate (Silventonen et al, 2003)[1]. Similarly, nutrition responsibility is still predominately a female dominated domain, with a considerably higher proportion of women responsible for food shopping and preparation compared with men (Caraher et al, 1999, Lake et al, 2006). Thus, if parents exhibit similar characteristics and their food is determined by maternal choice, it might be challenging to distinguish maternal and paternal effects. One strategy to identify some of such effects is to examine how such effect vary across parental and children age (cohort) groups.

[1] For instance, studies have reported correlations in spousal BMI values ranging from 0.10 to 0.15 (Allison et al., 1996).

In identifying the sources of intergenerational transmission is important to identify household heterogeneity, including children's attitudes towards food (Nicklas et al, 2001). There is some evidence of a significant parent-child association on fruit and vegetable intake (Bere et al, 2004). However, even when parents do not impose strict behavioural rules, children, consciously or unconsciously observe and model their behaviour after their parents, especially about fitness and food consumption which are largely gender specific (Pérez-Pastor et al, 2015).

There is limited consensus on the existence of a gender assortative transmission of intergenerational transmission. A study using Danish data the intergenerational transmission of overweight remains quite stable in terms of mother to child, whereas the father to child BMI correlation increased (Ajslev et al, 2014, Ajslev et al, 2015). In contrast, a study using Finish data for children born at the onset of the obesity epidemic, revealed that paternal and maternal effects were stronger for daughters than for sons (Jääskeläinen *et al*, 2011). Similarly, Whitaker *et al*, (2010) finds that mother–child's weight association is higher than father-child's one (Whitaker *et al*, 2010). However, other recent research suggests there is an increasing correlation of father and children's obesity and a reduction of the maternal link (Ajslev et al, 2014). Nonetheless, such evidence usually is based on small periods of time and, unlike our study, does not distinguish gender specific transmission effects and does not include as many relevant socio-economic controls.

In addition to direct parental transmission, confounding factors such as poverty, low income or female employment may play a role in the parents-children correlation of overweight (Classen, 2010, Costa-Font and Gil, 2013, Cavaco et al 2014), even when including only adopted children (Hruschka and Brewis, 2013). However, the effects may not be necessarily linear. Baum II and Ruhm (2007) find that an additional year of maternal education reduces obesity by an average of 0.2 kg/m2. Apouey and Geoffard (2016) find evidence that the effect of education follows an inverted U-shape across childhood, with a widening effect up until age 8, and narrowing afterwards. Finally, maternal employment may decrease maternal time available for overseeing children's activities, which generally results in increased sedentary activities as opposed to activities that have the positive effect of spending calories. Indeed, Anderson *et al.* (2003) suggest that there is a causal linkage of maternal employment on child's weight, especially for mothers working long hours although they did not focus on the intergenerational transmission of obesity and overweight. An exception is Costa-Font and Gil (2013) who find that after accounting for the intergenerational transmission of mother's labour market participation only explains obesity among boys but not among girls. Similarly, some evidence suggests that socially disadvantaged people have less access and ability to choose healthy behaviours (Wickrama et al, 1999).

3. Data and Methods

3.1 Data

We exploit the Health Survey for England (HSE). This cross-sectional survey started in 1991 and has been carried out annually since then. The HSE is a representative survey that contains detailed health and health-related behaviours, including weight and height, Body Mass Index (BMI) alongside a long list of variables such as fruit and vegetable consumption, alcohol intake and smoking in adults and children living in private households in England. The measurements of height and weight in the HSE are validated by a nurse, overcoming the problem of measurement error of these values present in other surveys containing children (Cawley et al 2015). The survey also contains the socio-economic status of the household and core information on all its members, including their relationship. Our pooled cross-section panel dataset results from merging information contained the thirteen waves that span from 1997 to 2009. The HSE contains records from adults aged 16 and over, since 1995 has also includes children aged 2-15, and since 2002 infants under 2 have been included. The information on children younger than 13 years is reported by their parents. During an interview with each person in the household, a nurse clinically measures the height and weight of survey participants alongside other variables.

[Insert Table 1 about here]

Table 1 reports the descriptive statistics if the variables that we employ in the study. Our two dependent variables are described in the top panel, namely the prevalence of obesity and overweight of children. We divide the children in three groups: pre-school, primary schooled children and teenagers. The prevalence of obesity and overweight increases from pre-school to school-aged children. Parental overweight and obesity also increases from when children are pre-schoolers to when they are teenagers, possibly partly due to the aging process of the parents but also possibly partially reflecting the so-called obesity epidemic. Our data contains also information on parental health, full time education of both father and mother. Other control variables are age, gender, two measures of health long standing illness, passive smoking, and ethnicity. Based on the literature review, we include maternal and paternal education, alongside income, flat ownership, the rural nature of the neighbourhood and family size. In one of our specifications we also use whether the child is a single child in order to test if that plays a role in the transmission.

3.2 Empirical Strategy

Our empirical strategy is based on a linearized health production function in which the latent overweight of a child is explained by non-genetic factors (age of the parents, their education and employment statuses, household's income, type of dwelling, and, being exposed to passive smoke); the child's own characteristics (age, gender, ethnic group); and, mutually exclusive indicator variables that take value 1 if both parents are overweight (obese); if only the mother is overweight (obese); or if only the father is overweight (obese). Assuming linearity, our main equation of interest is as follows:

$$o_{ij}^{*} = \delta_0 + \delta_b o_{ij}^{b} + \delta_M o_{ij}^{M} + \delta_F o_{ij}^{F} + \theta X_{ij} + \beta Z_j + v_{ij} \quad , (1)$$

where o_{ij}^{*} indicates the latent overweight (obese) of child *i* in household *j*; o_{ij}^{b} is an indicator variable for *both parents* of child *i* in household *j* being overweight (obese); o_{ij}^{M} takes value one if *only the mother* of child *i* in household *j* is overweight (obese); o_{ij}^{F} takes value one if *only the father* of child *i* in household *j* is overweight (obese); X_{ij} a vector of the child's characteristics including gender; Z_j is a vector with the parents' characteristics and and v_{ij} is the error term. Assuming normality of the error term, v_{ij}, the probability of observing that a child *i* in our sample is overweight or obese $(o_{ij} = 1)$ is the probability that the corresponding latent variable is positive. Therefore, in this framework, coefficients $\delta_b, \delta_M, and\ \delta_F$ will be estimates of the association between *both parents*, *only the mother* or *only the father* being overweight (obese) with the likelihood a child being overweight (obese).

Unlike previous literature which did not focus on gender assortative transmission, we aim to examine if the degree of transmission changes with children's age and gender. Thus, we estimate a number models that measure the magnitude and significance of the correlation between father and mother's overweight (obesity) and that of their children by age group and gender using a full set of interactions. We also test whether there are significant differences between the associations obtained by age groups, by gender, and by age and gender combinations. We include time trends both linear, quadratic and cubic but as the type of trend did not exert a major difference in the results, we report those obtained using a quadratic trend.

In the next section, we describe our benchmark results, followed by a number of extensions and robustness checks including testing if the mother being over 30, the child being a single child or ethnicity affect our benchmark findings.

4. Results

Our results are reported in Tables 2 to 6. In each we present estimates for three different parent-children combinations. The first panel of each table presents the results for the association between parents and child being overweight; the second panel relates parents' obesity and child's overweight; finally, the third panel presents the association of parents and children's obesity. Tables 2 and 5 contain three different specifications for each parents-child overweight (obesity). The first specification does not include controls, only the overweight (obesity) of the parents and a control for the child's gender; the second one incorporates whether the child is in school or is a teenager; and the third one adds a full set of controls such as household size; the child having a long illness; being exposed to passive smoking; the child's ethnicity; whether the mother works full time; whether the parents are natural parents; whether the mother has mental health or health problems; whether the father has mental health or health problems; the parents' education; if the household lives in a rural dwelling; if they own their home; and, the logarithm of the household income. As the dependent variable in all these models is discrete, taking values equal to 1 (when the child is overweight/obese) and to 0 (otherwise), we estimate our models using probit specifications with robust standard errors and clustered by household (as we have several children in some of the households).

Baseline results

Table 2 presents the coefficients when both girls and boys are included in the sample and gender (girl) is included as a control. Table 3 presents the t-tests statistics and corresponding p-values of a battery of tests of equality of the coefficients presented in Table 2.

[Insert Table 2 about here]

Results in Table 2 are consistent with the existence of a strong transmission of overweight and obesity when both parents are overweight or obese, the association is positive and significant for both boys (main effect) and even larger for girls (interaction).

The second column of each panel, which does not decompose the effect by age-gender groups, shows that the likelihood of a pre-school boy (the omitted category) to be overweight is 19.8pp larger when both parents are overweight and 26.7pp when both parent are obese.

If only one parent is overweight there is also an increase in the chances that a pre-school boy of is overweight (6.6pp because of the mother only, 7.1pp because of the father) or obese (12.9pp for mothers, 9.6pp for fathers). When the child is a girl her likelihood of being overweight is 6.6pp higher when both parents are overweight and 9.3pp higher when they are both obese; if only her mother is overweight (obese) the likelihood of the girl being overweight is increased by 5.7pp (by 5.9pp). This is consistent with previous evidence from Britain suggesting that girls exercise less and spend more time at home compared to boys of equivalent age.

Independently of the parental overweight, if the boy is in school age instead of a pre-schooler, his likelihood of being overweight is increased by 4.5pp and of being obese by 4.5pp. If the boy is a teen instead, the likelihood increases are 3.9pp and 4.2pp, respectively.

The results in the second column of the third panel indicates that having obese parents increases the likelihood of having an obese pre-school boy (11.8pp), and even more, if she happens to be a girl (adding 5.6pp). Having an obese mother alone increases the likelihood of the pre-school boy being obese (by 4.7pp) but this does not change statistically significantly if the offspring is a girl instead. Similarly, if only the father is obese, the likelihood of the pre-school boy being obese increases (by 3.3pp) but again being a girl does not have an additional statistically significant effect. Nevertheless, if only either the father or the mother are obese, their school-aged or teenager sons have a smaller chance of being overweight or obese.

Independently of the parents' overweight, being in school age instead of a pre-schooler increases the chances of the boy being obese by 0.9pp but being a teenager does not affect the likelihood of obesity significantly.

When we examine the specific effect of transmission by age groups in the third column of each panel in Table 2, we uncover that boys in their teens with both parents overweight or obese face an increased probability of being overweight (by 10.1pp and 17.0pp, respectively). If only their father is overweight and they are in school instead, they have an increased probability of being overweight (by 4.4pp) but have lower chances of being obese than a pre-schooler boy (by 3.4pp). School-age girls with an overweight or obese mother have an increased likelihood of being overweight (by 11.8pp and 14.3pp, respectively) or obese (7.2pp). If the girl is in their teens and her mother is obese, she has an increased chance of being overweight (by 16.6pp) or obese (by 8.6pp).

[Insert Table 3 about here]

Tests in Table 3 are useful to establish if the transmission is gender-assortative by answering the questions listed in the first column of Table 3. Each question is associated to a null hypothesis on equality of coefficients. The questions are: "Is the association of the father being overweight (obese) with the overweight (obesity) of his son different than with that of the daughter?"; "Is the association of the mother being overweight (obese) with the overweight (obesity) of his son different than with that of the daughter?"; "Is the association of both parents being overweight (obese) with the overweight (obesity) of his son different than with that of the daughter?"; "Is the father's overweight (obesity) association with the overweight (obesity) of their male (female) offspring statistically different than that of the mother's?"; "Is the association of both parents being overweight (obese) with that of their male (female) offspring differ by child's age?"; "'Is the association of the father being overweight (obese) with that of their male (female) offspring differ by child's age?"; and, finally, "Is the association of the mother being overweight (obese) with that of their male (female) offspring differ by child's age?".

When we estimate all ages pooled together (results corresponding to first column of each panel in Table 3), boys seem to be affected differently than girls by both parents or one of them alone being obese. However, when one parent alone is overweight, the effect of the father is different than that of the mother for girls.

When we analyse the transmission by age group (results corresponding to the second column of each panel in Table 3) we observe that maternal obesity influences differently the likelihood of sons and daughters being obese, especially when they are pre-schoolers. Father's obesity is also transmitted differently to boys than to girls when they are in pre-school, and father's overweight is transmitted different to boys than to girls when they are in school.

When both parents are overweight, school-age and teenage girls' chances of being overweight or obese are affected differently than that of boys in the same age group. When both parents are obese, the likelihood of their teenage daughters being obese is statistically different than that of their sons but this is not the case for children in school-age. These results are important and deviate from previous findings that suggest stronger maternal obesity transmission mainly affected schoolgirls. Instead, we find a stronger effect when both parents are obese, especially among teenage children.

When we look if the transmission when both parents are (or just one of them is) overweight or obese by age group, a more detailed picture appears:

Both parents being overweight affects different school-boys than pre-schooler boys, and the transmission of overweight is different for school-aged boys than for teenage boys. For girls, both parents being overweight affects differently each age group except for pre-school and school-aged girls. When both are obese, the likelihood of daughters being overweight is different for each age group. The transmission of obesity when both parents are obese seems to be similar by age groups for both boys and girls.

When the father is overweight, the transmission of overweight to sons is similar for all ages, i.e. we do not reject the null that the transmission is the same. For girls, we find the same result. When the father is obese, though, the increased likelihood of being overweight or obese is different for preschool boys than for school and teen boys. For girls, the null that the effect by age groups is the same cannot be ruled out.

When the mother is overweight, the increased likelihood of being overweight for teenage and pre-school boys is different, but not for the rest of pairwise age-group comparisons. Instead, when the mother is obese, both pre-school boys and pre-school girl's chances of being overweight and obese are differently affected than those of school-aged boys and school aged-girls.

Single child heterogeneity

One potential mechanism underlying the above results could be that there is a single child in the family. Single children are more likely to attract their parents' undivided attention and thus potentially receive more food than they need. Table 4 discards this hypothesis. As shown in this table, we do not find evidence that being a single child has a statistically significant effect on the intensity of the intergenerational transmission of overweight. The only exception is when both parents are obese, in which case a single child the probability of a single child being overweight increases by 8.6pp.

[Insert Table 4 about here]

Parental age effects

Table 5 shows the gender specific association between parents and children overweight allowing a heterogeneous effect by parental age. In the first panel of Table 5, the measure of parental age is whether the mother was above the age of 30 when giving birth to the child, which we interact with both parents, the mother or the father being overweight (obese). We find that whilst mothers that were above 30 at the time of birth are less likely to have overweight and obese children, if they are obese, they are more likely to have an overweight child (by 4.8pp). Mothers over the age of 30 at birth living in a household in which the father is overweight or obese are more likely to have overweight (by 5.0pp and 8.9pp, respectively) and obese boys (by 3.1pp) consistent with assortative transmission effects, although if the offspring is a girl, these likelihoods are reduced.

When we look at the distance in age between the mother and the child, in the second panel in Table 5, or the distance in age between the father and the child, in the third panel, we observe that, in general, the age distance has a negative effect on the likelihood of the child being obese. But, when both parents or just the father are obese, the likelihood of the offspring being overweight or obese increases with the age distance. This association is intensified when the offspring is a girl.

[Insert Table 5 about here]

Ethnicity effects

Finally, Table 6 contains the estimates of ethnicity specific association between parents' and children overweight and obesity. The main finding is that while being white reduces the chances of a boy being obese, when both parents or only the father are obese, the chances of their offspring being overweight are increased, the chances of being obese is only affected by both parents being obese but not the father or the mother alone.

[Insert Table 6 about here]

5. Conclusion

We have intergenerational transmission of overweight, and specifically the hypothesis of gender assortative transmission of overweight from parents to offspring and whether such transmission alters by the age group of the child. We use unique data that pools together thirteen waves of the Health Survey for England to explore the existence of associations between parental obesity and overweight and those of their children and investigate different variations that could explain the associations such as being a single child, having older parents or the ethnicity.

Consistently with previous studies, we document evidence of an intergenerational transmission of overweight, mainly when both parents are overweight. Our preferred interpretation is that when both parents are overweight it has a reinforcing effect on their household members, especially under the presence of assortative mating. That is, the child ‘obesogenic environment’ is stronger when both parents are obese or overweight, especially under restrictive role modelling or gender specific effects, as we discuss below.

Our results are heterogeneous by gender, by age group and by both gender and age group. We find some restrictive evidence of assortative transmission, namely the effect of fathers’ overweight and obesity is different than that of mothers for girls (especially by raising their chances of being overweight). When the mother is obese, the transmission of overweight and obesity to pre-school boys is different than that to girls. The transmission of overweight if the father is overweight to school-age children varies by gender. If instead he is obese, gender differences only apply to pre-school children.

Teenagers appear to be more receptive to parental transmission of both parents overweight but not maternal or paternal specific effects which is consistent with the fact that, at that age, children are more sensitive to social cues (Fehr et al, 2008) although this is due also possibly to a cumulative pattern in the transmission of health behaviours from parents to their children. Other findings suggest some evidence of a specific effect of dad's and among boys, and fathers overweight on boys when paternal age exceed 30 years of age. Specifically, mothers over the age of 30 in household with fathers overweight or obese are more likely to have overweight boys. Finally, transmission of stronger among white children.

We also obtain interesting results suggestive of a heterogeneous transmission by age group for boys and girls separately. Mainly, both parents being overweight increases the chances of their sons being overweight differently by age group. When only one parent is overweight or obese, the differences by age apply when the father is obese on overweight sons and when the mother is obese on both boys and girls.

The implications of the study are that policies aimed at reducing children's obesity should especially focus on families where both parents are obese or overweight as they are likely to influence their children up and above the obvious genetic influence. Second, our findings suggest that the effects are stronger among certain age groups, the latter might well result from the fact that environmental pressures are both gender and age specific. That is, parentsl effects affect boys (teenage age) and girls (school age) at different ages.

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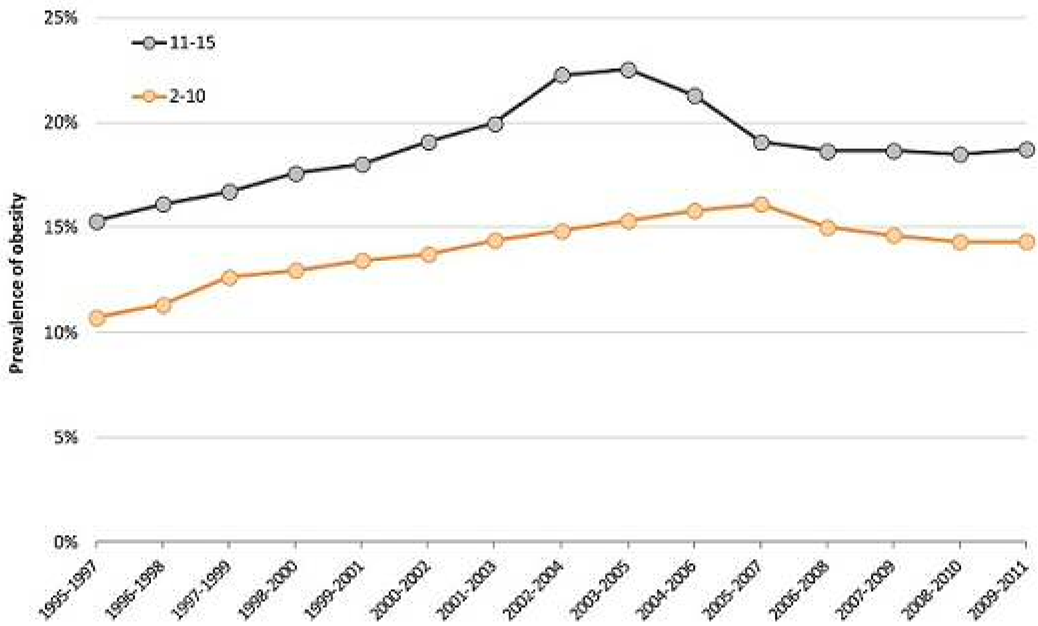
Figures and Tables

Figure 1. Patterns of child obesity in England 1995- 20011 by age group



Source: Public Health England, 2013
http://www.noo.org.uk/NOO_about_obesity/child_obesity/UK_prevalence

Table 1: Summary Statistics for the Full Sample and by Age Group

		Child Type			
		Pre-School	Child	Teenager	Total
	Number of observations	(2907)	(7423)	(4071)	(14401)
Overweight	Obese (%)	4.9	6.1	5.8	5.8
	Overweight (%)	19.3	24.8	24.8	23.7
Age	Mean number of years	4.02	9.01	14.46	9.55
	Standard Deviation number of years	(0.80)	(1.98)	(1.10)	(3.95)
Gender	Girl (%)	50.2	49.3	48.4	49.2
	Boy (%)	49.8	50.7	51.6	50.8
Health	Long Standing Illness (%)	18.1	19.4	21.5	19.7
	Passive Smoking (%)	21.5	25.5	27.9	25.4
Ethnicity	White (%)	78.1	79.2	79.4	79
	Black (%)	5	4.2	3.6	4.2
	Ind/Pak/Bang (%)	4.1	3.9	3.8	3.9
	Other (%)	12.8	12.6	13.2	12.8
Parents	Mother Obese (%)	18	21.8	24.4	21.8
	Dad Obese (%)	20.4	22.9	25.2	23
	Mum Overweight (%)	48.5	53	59	53.8
	Dad Overweight (%)	68.4	71.7	74.6	71.9
Parents' Mental Health	Mother (%)	2.8	2.6	3	2.8
	Dad (%)	1.8	1.7	2.3	1.9
Parents' Full Time	Mother Works Full Time (%)	59	70.8	77.4	70.3
	Dad Works Full Time	90.57	90.04	89.04	89.86
Parents' Education	MumEd:NA	9.6	13.2	17.1	13.6
	MumEd:Nvq5-HE	33.1	29.6	27.5	29.7
	MumEd:A/O Level	48.8	49.4	46.7	48.5
	MumEd:CSE	6.5	6	6.3	6.2
	MumEd:Foreign	1.9	1.8	2.3	2
	Dad˙Ed:NA	12.3	14.5	19.5	15.5
	DadEd:Nvq5-HE	42.1	40.1	38.7	40.1
	DadEd:A/O Level	38.4	38.7	35.2	37.7
	DadEd:CSE	6.1	5.5	5.1	5.5
	DadEd:Foreign	1.1	1.2	1.4	1.2
Nuclear Family	Family of 3	14.1	8.8	13.6	11.2
Rural	Living in Rural Area	19.7	22.1	23	21.9
Dwelling	Own the flat	77.9	81	83.1	81
Income	Mean	£34,906.63	£36,462.20	£35,361.18	£35,836.94
	Standard Deviation	(41459.61)	(43,203.12)	(48,846.61)	(41,459.61)

Summary statistics of main variables by children's age group.
Source: *Health Survey for England.*

Table 2 General: All OLS Models Obese to Overweight									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Parents:	Overweight	Overweight	Overweight	Obese	Obese	Obese	Obese	Obese	Obese
Child:	Overweight	Overweight	Overweight	Overweight	Overweight	Overweight	Obese	Obese	Obese
Both Ob/Ov	0.201***	0.198***	0.146***	0.266***	0.267***	0.150***	0.122***	0.118***	0.065**
	(0.013)	(0.013)	(0.026)	(0.024)	(0.024)	(0.050)	(0.016)	(0.016)	(0.032)
Both Ob/Ov - Girl	0.071***	0.066***	0.076**	0.098***	0.093***	0.220***	0.051**	0.056**	0.093*
	(0.018)	(0.019)	(0.033)	(0.033)	(0.034)	(0.075)	(0.025)	(0.026)	(0.056)
Only Mum Ob/Ov	0.071***	0.062***	0.059*	0.132***	0.129***	0.126***	0.050***	0.047***	0.046***
	(0.016)	(0.016)	(0.031)	(0.016)	(0.016)	(0.016)	(0.009)	(0.009)	(0.009)
Mum Ob/Ov - Girl	0.058**	0.057**	-0.008	0.064***	0.059***	-0.066*	0.019	0.020	-0.044**
	(0.023)	(0.024)	(0.041)	(0.022)	(0.023)	(0.038)	(0.014)	(0.014)	(0.020)
Only Dad Ob/Ov	0.070***	0.071***	0.038*	0.099***	0.096***	0.095***	0.032***	0.033***	0.032***
	(0.013)	(0.013)	(0.023)	(0.015)	(0.015)	(0.015)	(0.008)	(0.008)	(0.008)
Dad Ob/Ov - Girl	0.015	0.014	0.035	0.051**	0.051**	0.016	-0.004	-0.006	-0.014
	(0.018)	(0.018)	(0.028)	(0.021)	(0.022)	(0.037)	(0.011)	(0.011)	(0.019)
Girl	0.011	0.015	0.014	0.029***	0.031***	0.030***	0.013***	0.015***	0.015***
	(0.013)	(0.014)	(0.014)	(0.008)	(0.008)	(0.008)	(0.004)	(0.004)	(0.004)
School Child		0.045***	0.012		0.045***	0.048***		0.009*	0.014**
		(0.009)	(0.017)		(0.009)	(0.011)		(0.005)	(0.006)
Teen		0.039***	-0.011		0.042***	0.049***		0.001	-0.001
		(0.011)	(0.020)		(0.011)	(0.014)		(0.006)	(0.007)
Both Ob/Ov - School			0.048*			0.093			0.036
			(0.029)			(0.057)			(0.039)
Both Ob/Ov - School Girl			0.006			-0.103			-0.020
			(0.034)			(0.084)			(0.067)
Both Ob/Ov - Teen			0.101***			0.170***			0.084*
			(0.033)			(0.066)			(0.044)
Both Ob/Ov - Teen Girl			-0.038			-0.233**			-0.084
			(0.038)			(0.094)			(0.070)
Mum Ob/Ov - School			-0.015			-0.049***			-0.024***
			(0.036)			(0.016)			(0.009)
Mum Ob/Ov - School Girl			0.118**			0.143***			0.072***
			(0.047)			(0.041)			(0.023)
Mum Ob/Ov - Teen			0.045			-0.067***			-0.036***
			(0.043)			(0.022)			(0.010)
Mum Ob/Ov - Teen Girl			0.017			0.166***			0.086***
			(0.054)			(0.047)			(0.027)
Dad Ob/Ov - Teen			0.041			-0.055***			-0.012
			(0.030)			(0.016)			(0.008)
Dad Ob/Ov - Teen Girl			-0.013			0.050			0.026
			(0.034)			(0.046)			(0.024)
Dad Ob/Ov - School			0.044*			-0.034***			-0.025***
			(0.026)			(0.012)			(0.006)
Dad Ob/Ov - School Girl			-0.033			0.042			0.003
			(0.029)			(0.039)			(0.020)
˙cons	0.099***	0.116	0.150	0.158***	0.105	0.117	0.027***	-0.015	-0.010
	(0.009)	(0.098)	(0.099)	(0.006)	(0.097)	(0.097)	(0.002)	(0.059)	(0.059)
Observations	14277	13592	13592	14277	13592	13592	13592	13592	13592
Note: Robust Standard Errors in Parentheses									

Table 3: Test of Equality of Coefficients

	Overweight Parents to Overweight Children		Obese Parents to Overweight Children		Obese Parents to Obese Children	
	Some controls	All controls	Some controls	All controls	Some controls	All controls
Both effect: Girls different to boys?						
All	0.13 (0.02)		0.17 (0.05)		0.06 (0.0370	
pre		No		No		No
sch		0.11 (0.03)		0.12 (0.07)		No
teen		0.20 (0.04)		0.33 (0.09)		0.14 (0.07)
Dad's effect: Girls different to boys?						
All	0.05 (0.028)		No		0.26 (0.02)	
pre		No		0.079 (0.04)		0.04 (0.02)
sch		0.07 (0.03)		No		No
teen		No		No		No
Mum's effect: Girls different to boys?						
All	No		0.06 (0.03)		No	
pre		No		0.19 (0.04)		0.08 (0.02)
sch		No		No		No
teen		No		No		No
Dad's effect different than Mum's for boys?						
all	No		No		No	
pre		No		No		No
sch		-0.038 (0.02)		No		No
teen		No		No		No
Dad's effect different than Mum's for girls?						
all	0.34 (0.017)		0.040 (0.022)		0.041 (0.013)	
pre		No		-0.080 (0.11)		No
sch		0.069 (0.024)		0.085 (0.123)		0.053 (0.019)
teen		No		0.098 (0.121)		NO
Both effect different by age for boys?						
pre-sch		0.09 (0.05)		No		No
pre-teen		No		No		No
teen-sch		0.05 (0.02)		No		No
Both effect different by age for girls?						
pre-sch		No		0.32 (0.15)		NO
pre-teen		0.11 (0.06)		0.45 (0.15)		NO
teen-sch		-0.04 (0.03)		-0.013 (0.073)		NO
Dad's effect different by age for boys?						
pre-sch		No		0.129 (0.019)		0.057 (0.010)
pre-teen		No		0.149 (0.02)		0.044 (0.011)
teen-sch		No		No		No
Dad's effect different by age for girls?						
pre-sch		No		No		No
pre-teen		No		No		No
teen-sch		No		No		No
Mum's effect different by age for boys?						
pre-sch		No		0.17 (0.02)		0.070 (0.013)
pre-teen		No		0.19 (0.02)		0.081 (0.012)
teen-sch		0.06 (0.03)		No		No
Mum's effect different by age for girls?						
pre-sch		No		-0.20 (0.07)		-0.11 (0.03)
pre-teen		No		-0.23 (0.03)		-0.12 (0.04)
teen-sch		-0.01 (0.047)		No		No

Note: This table shows the T-test statistics and corresponding p-values for the statistically significant results of corresponding tests of equality of coefficients in columns 2 and 3 of each panel in Table 2. Null hypotheses for each question is yes. We apply lincom in Stata 14.0 to test equality of coefficients. We report NO when the null

Table 4 All OLS Models Obese to Overweight - Single Child

	(1)	(2)	(3)
Parents:	Overweight	Obese	Obese
Child:	Overweight	Overweight	Obese
Single Child	0.052	-0.004	0.009
	(0.039)	(0.038)	(0.020)
Girl	0.013	0.036***	0.016***
	(0.014)	(0.009)	(0.004)
Single Child and Girl	0.000	-0.022	0.010
	(0.051)	(0.050)	(0.029)
Both Ob/Ov	0.201***	0.264***	0.114***
	(0.014)	(0.025)	(0.017)
Both Ob/Ov and Girl	0.074***	0.093***	0.057**
	(0.020)	(0.034)	(0.026)
Both Ob/Ov and Single Child	-0.017	0.086*	0.042
	(0.047)	(0.046)	(0.026)
Both Ob/Ov Single Girl	-0.046	-0.004	-0.019
	(0.065)	(0.063)	(0.039)
Only Mum Ob/Ov	0.062***	0.128***	0.046***
	(0.017)	(0.016)	(0.009)
Mum ObOv and Girl	0.056**	0.057**	0.017
	(0.025)	(0.023)	(0.014)
Mum Ob/Ov and Single Child	-0.002	0.018	-0.036
	(0.059)	(0.057)	(0.025)
Mum Ob/Ov Single Girl	0.027	0.033	0.064
	(0.085)	(0.082)	(0.048)
Only Dad Ob/Ov	0.070***	0.094***	0.031***
	(0.014)	(0.015)	(0.008)
Dad Ob/Ov and Girl	0.022	0.053**	-0.003
	(0.019)	(0.022)	(0.011)
Dad Ob/Ov and Single Child	0.008	0.056	0.009
	(0.048)	(0.046)	(0.024)
Dad Ob/Ov Single Girl	-0.070	-0.069	-0.063*
	(0.066)	(0.063)	(0.033)
Intercept	0.154*	0.150*	-0.009
	(0.091)	(0.090)	(0.053)
Observations	13592	13592	13592
Note: Robust Standard Errors in Parentheses			

Table 5: All OLS Models Obese to Overweight - Control for Age differences”

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Mother over 30			Age distance : Mother & child			Age distance : Father & child		
Parents:	Overweight	Obese	Obese	Overweight	Obese	Obese	Overweight	Obese	Obese
Child:	Overweight	Overweight	Obese	Overweight	Overweight	Obese	Overweight	Overweight	Obese
Both Ob/Ov	0.224***	0.288***	0.140***	0.213***	0.234***	0.120***	0.195***	0.233***	0.119***
	(0.013)	(0.019)	(0.013)	(0.057)	(0.020)	(0.014)	(0.054)	(0.020)	(0.014)
Mum Ob/Ov	0.088***	0.143***	0.054***	0.127*	0.109***	0.041***	0.153**	0.109***	0.041***
	(0.016)	(0.013)	(0.007)	(0.068)	(0.013)	(0.008)	(0.065)	(0.013)	(0.008)
Dad Ob/Ov	0.065***	0.106***	0.027***	0.081	0.086***	0.020***	0.103*	0.086***	0.020***
	(0.013)	(0.012)	(0.006)	(0.057)	(0.012)	(0.006)	(0.054)	(0.012)	(0.006)
Girl	0.056***	0.056***	0.024***	0.027**	0.027**	0.015**	0.030**	0.030**	0.011*
	(0.009)	(0.009)	(0.005)	(0.014)	(0.014)	(0.006)	(0.014)	(0.014)	(0.007)
Mum over 30	-0.019	-0.087***	-0.023***						
	(0.015)	(0.012)	(0.005)						
Both Ob/Ov Mum over 30	0.012	0.135***	0.026***						
	(0.023)	(0.019)	(0.010)						
Mum Ob/Ov Mum over 30	0.004	0.048**	0.016						
	(0.029)	(0.024)	(0.012)						
Dad Ob/Ov Mum over 30	0.050**	0.089***	0.031***						
	(0.022)	(0.018)	(0.008)						
Both Ob/O Mum over 30 Girl	0.016	0.021	0.010						
	(0.024)	(0.023)	(0.013)						
Mum Ob/Ov Mum over 30 Girl	-0.001	-0.009	-0.010						
	(0.033)	(0.033)	(0.018)						
Dad Ob/Ov Mum over 30 Girl	-0.034	-0.033	-0.032***						
	(0.021)	(0.021)	(0.010)						
Age distance parent-child				-0.000	-0.003***	-0.001**	0.000	-0.003***	-0.001
				(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Both Ob/Ov * Age dist				-0.000	0.004***	0.001***	0.000	0.004***	0.001***
				(0.002)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)
Mum Ob/Ov * Age dist				-0.002	0.001*	0.000	-0.003	0.001**	-0.000
				(0.002)	(0.001)	(0.000)	(0.002)	(0.001)	(0.000)
Dad Ob/Ov * Age dist				-0.000	0.002***	0.000**	-0.001	0.002***	0.000*
				(0.002)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)
Both Ob/Ov * Age dist * girl				0.002***	0.002***	0.001*	0.002***	0.002***	0.001**
				(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Mum Ob/Ov * Age dist * girl				0.001*	0.001	0.000	0.001	0.001	0.001
				(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
Dad Ob/Ov * Age dist * girl				0.000	0.000	-0.000	-0.000	-0.000	-0.000
				(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
School Child	0.044***	0.042***	0.008	0.044***	0.040***	0.007	0.045***	0.041***	0.008
	(0.009)	(0.009)	(0.005)	(0.009)	(0.009)	(0.005)	(0.009)	(0.009)	(0.005)
Teen	0.040***	0.039***	-0.000	0.039***	0.034***	-0.002	0.039***	0.035***	-0.001
	(0.011)	(0.011)	(0.006)	(0.011)	(0.011)	(0.006)	(0.011)	(0.011)	(0.006)
Intercept	0.104	0.104	-0.012	0.122	0.145	0.005	0.108	0.132	-0.002
	(0.099)	(0.098)	(0.060)	(0.106)	(0.099)	(0.060)	(0.106)	(0.099)	(0.060)
Observations	13588	13588	13588	13588	13588	13588	13588	13588	13588
Note: Robust Standard Errors in Parentheses									

Table 6 All OLS Models Obese to Overweight - W

	(1)	(2)	(3)
Parents:	Overweight	Obese	Obese
Child:	Overweight	Overweight	Obese
White	-0.001	-0.090***	-0.045***
	(0.029)	(0.025)	(0.014)
Girl	0.012	0.023	0.012
	(0.028)	(0.016)	(0.009)
White Child and Girl	0.003	-0.008	-0.003
	(0.032)	(0.023)	(0.011)
Both Ob/Ov	0.217***	0.217***	0.100***
	(0.028)	(0.026)	(0.017)
Both Ob/Ov and Girl	0.066*	0.077**	0.053**
	(0.039)	(0.036)	(0.026)
bothwhite	-0.022	0.119***	0.034***
	(0.032)	(0.017)	(0.008)
Both Ob/Ov White Girl	0.002	0.038	0.010
	(0.045)	(0.023)	(0.012)
Only Mum Ob/Ov	0.071**	0.104***	0.038***
	(0.032)	(0.017)	(0.010)
Mum ObOv and Girl	0.052	0.042*	0.014
	(0.048)	(0.025)	(0.015)
Mumo White	-0.012	0.023	-0.001
	(0.037)	(0.019)	(0.008)
Mum Ob/Ov White Girl	0.009	0.045	0.021
	(0.055)	(0.028)	(0.014)
Only Dad Ob/Ov	0.088***	0.071***	0.026***
	(0.029)	(0.016)	(0.008)
Dad Ob/Ov and Girl	0.008	0.050**	-0.006
	(0.039)	(0.022)	(0.012)
dadowhite	-0.022	0.049***	0.006
	(0.033)	(0.015)	(0.006)
Dad Ob/Ov WHite Girl	0.008	0.002	0.002
	(0.044)	(0.021)	(0.009)
Intercept	0.180**	0.205**	0.018
	(0.091)	(0.089)	(0.053)
Observations	13356	13356	13356
R-squared	0.057	0.073	0.044
Adjusted R-squared	0.055	0.070	0.042

Note: Robust Standard Errors in Parentheses

Appendix (for online publication alone)

Table A1. Means and Standard deviation

Variable	Description	Observations	Mean	(Std. Dev)
Obese	Child Clinically measured BMI - Obese =1	14277	0.057	-
Ovrweight	Child Clinically measured BMI – Overweight =1	14277	0.237	-
Obboth	Parent Clinically measured BMI –Both Obese =1	14277	0.072	-
ovboth	Parent Clinically measured BMI –Both Overweight =1	14277	0.405	-
obmumo	Parent Clinically measured BMI –Mother Obese =1	14277	0.144	-
ovmumo	Parent Clinically measured BMI – Mother Overweight=1	14277	0.132	-
obdado	Parent Clinically measured BMI – Father Obese=1	14277	0.157	-
ovdado	Parent Clinically measured BMI – Father Overweight=1	14277	0.312	-
girl	Female Child =1	14277	0.492	-
sch	School Aged Child=1	14277	0.515	-
teen	Teenage Child =1	14277	0.281	-
longill	Long Standing Illness =1	14277	1.803	-
passm2	Passive Smoking =1	14275	0.252	-
momft	Mother works full time	14277	0.702	-
natmom	Natural mon=1	14277	1	-
natdad	Natural dad=1	14277	0.892	-
m_menthea	Maternal mental health	14277	1.972	(0.164)
f_menthea	Paternal mental health	14277	1.980	(0.136)
m_ed	Maternal education	14277	1.533	(0.873)
f_ed	Paternal education	14277	1.371	(0.851)
rural	Lives in rural area=1	14274	0.219	-
ownflat	Owns a property=1	14277	0.810	-
lninc	Household income (logs)	14277	9.327	(3.072)
hhsize	Household size	13604	4.336	(0.901)
nucfam	Nuclear family	14277	0.112	-
time	Time	14277	6.362	(3.659)
white	White ethnicity	14270	0.790	-