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Article

The impact of maternal employment on children's weight: Evidence from the UK

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ABSTRACT

Previous research shows that maternal employment is associated with higher children's body mass index (BMI). Using a large UK longitudinal birth cohort study of almost 20,000 children, we examine the effect of maternal employment during childhood (to age 14) on children's weight. We address the endogeneity of maternal employment by estimating household fixed effects models. We find that maternal employment has a positive effect on children's BMI and therefore on excess weight, and this is particularly the case for single mothers. We investigate potential pathways, including children's sedentary behavior and healthy eating behaviors, and find evidence of more sedentary behavior and poorer eating habits amongst children whose mothers are in employment. This is consistent with higher BMI levels amongst these children.

1. Introduction

Spending by the National Health Service (NHS) in England on overweight and obesity-related ill-health was estimated at £5.1 billion in 2014/15 (HM Government, 2016). Obesity is the most common chronic disease of childhood, and likely to persist into adulthood (Reilly & Kelly, 2011) with far-reaching effects. Physical health risks, including high blood pressure and cholesterol, type 2 diabetes, and sleep apnea, present themselves in the short- and long-term (Bhave, Bavdekar, Otiv, & National Task Force for Childhood Prevention of Adult Diseases: Childhood Obesity, 2004; Biro & Wien, 2010; Craigie, Lake, Kelly, Adamson, & Mathers, 2011; Ng, Fleming, & Robinson, 2014). Psychological effects including low self-esteem and depression also manifest throughout life (Schwimmer, Burwinkle, & Varni, 2003). Economic outcomes such as wages are also affected adversely (Cawley, 2004). With disadvantaged children increasingly more likely to display excess weight (Shrewsbury & Wardle, 2008), understanding the factors contributing to excess weight in childhood is also important to reducing the intergenerational transmission of inequality.

This paper's motivation stems from three stylised facts. First, the prevalence of childhood overweight and obesity has soared recently. The number of obese children and teenagers across the world has increased tenfold over the past four decades: from 1975 to 2016, the number of obese girls (boys), aged 5 to 19, rose from 5 m to 50 m (6 m to 74 m) (NCD Risk Factor Collaboration (NCD-RisC) 2017). Second, maternal employment has increased dramatically over this period. For instance, among mothers with children under 18 in the US, 47% were in the labour force in 1975, rising to more than 70% in the late 1990s, where it has remained over the last 15 years (Galinsky, Aumann, & Bond, 2013; Pilkauskas, Waldfogel, & Brooks-Gunn, 2016). The UK has also seen a rise in the proportion of women aged 16 to 64 in employment over the past 40 years, from 53% in 1971 to 67% in 2013 (ONS, 2013). The rate of increase in employment has been fastest for mothers, particularly those with pre-school children – rising from 31% in 1980 to 58% in 2008, amongst mothers with a child under five (Fagan & Norman, 2012; OECD 2011). A third stylised fact is the rise in the number of single-parent households in the UK over recent decades. For instance, amongst children born in 2000/01, 23.8% of them lived with a single mother at the age of 11, compared to around 7% for those born in 1958.[2]

In this paper, we investigate whether changes in maternal employment have contributed to increased childhood weight, and whether family structure plays a role. The majority of existing evidence on this topic is US-based, and is mostly concerned with associations rather than causal effects. The contribution of our study is threefold. First, it is the first paper providing causal evidence on the effect of maternal

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[2] Author's calculations using Millennium Cohort Study and National Child Development Study.

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employment on children's weight in the UK, for a large contemporaneous cohort that has grown up in the midst of the childhood 'obesity epidemic'. Second, it is one of the first papers on this topic to distinguish between mothers who are single and partnered – a key distinction, with just under one quarter of our sample of children raised in a one-parent family. Third, it provides evidence on the mechanisms underlying the effects, adding to the limited body of evidence on this topic.

Excess weight is due to a changing energy balance, i.e. consuming more calories than expended (Hill, Wyatt, & Peters, 2012), and there are several ways in which parental - and maternal in particular - working may affect this in children. First, an increase in employment means that parents (mothers) spend less time at home, with less time allocated to housework, including meal preparation (Monsivais, Aggarwal, & Drewnowski, 2014). Gershuny and Fisher (2000) provide evidence that the time British women spend cooking has always been less for employed than non-employed mothers. Second, the child will spend more time in the care of other family members and in childcare. This reduction in parental (maternal) child supervision may have adverse implications for choices concerning food intake (Klesges, Stein, Eck, Isbell & Klesges, 1991) and physical activity (Cawley & Liu, 2012). Conversely, an increase in employment results in higher family income, making healthier, more nutritious foods – typically more expensive than processed foods - more affordable. These mechanisms may operate differently depending on whether the mother has a partner or not: married parents have higher average family incomes than single parents (Duncan & Hoffman, 1985; Fronstin, Greenberg, & Robins, 2001; Ribar, 2004); partnered parents have more time, jointly, to spend with their children than single parents (Fronstin, Greenberg and Robins 2001; Lopoo & De Leire, 2014). Previous work found a strong relationship between single-parent status and excess weight in children in the US (Huffman, Kanikireddy, & Patel, 2010).

Applying household fixed effects on detailed longitudinal data from the UK Millennium Cohort Study, we find that maternal employment increases children's BMI. We investigate the mechanisms underlying the observed effects, and whether an imbalance between energy expenditure (sedentary behavior) and energy intake (healthy dietary habits) contributes to the effects. We find that children of working mothers are more likely to be sedentary and less likely to eat breakfast regularly. This is consistent with an overall positive effect on children's BMI.

The paper proceeds as follows. Section 2 discusses related literature and background; in Section 3 we describe the data, followed by the empirical methodology in Section 4. Section 5 presents the main findings and potential mechanisms, and Section 6 concludes.

2. Background

Over the past couple of decades, a growing body of literature has explored whether maternal employment raises the risk of childhood obesity. The majority of this literature, reviewed in Anderson (2011), estimates associations between maternal employment and children's weight. Far fewer studies attempt a credible identification strategy to estimate the causal effect of maternal employment on children's weight. The study of Anderson, Butcher, and Levine (2003) was the first to attempt to estimate a causal relationship, finding in a US context that mothers' full-time work over her child's life increased the probability that her child was overweight. Subsequent studies with a credible identification strategy, including instrumental variables and/or fixed effects, have mostly focused on the US (Anderson et al., 2003; Courtemanche 2009; Courtemanche, Tchernis, & Zhou, 2017; Fertig, Glomm, & Tchernis, 2009; Morrissey, Dunifon, & Kalil, 2011; Ruhm, 2008), with a limited number of non-US studies (Bishop 2011; Dunifon, Hansen, Nicholson, & Nielsen, 2013; Greve 2011; Scholder, 2008). With the exception of Bishop (2011) and Greve (2011), all of this evidence finds that maternal employment increases children's BMI.

Compared to the US, there is a dearth of research looking at this issue in a UK context. Existing studies mainly use the Millennium Cohort Study, and include Hawkins, Cole, and Law (2008), who estimate positive associations between maternal employment and early childhood overweight when study members were aged three. A more recent study using MCS data at age 7 finds that prolonged maternal full-time employment is associated with an elevated risk of child overweight (Hope, Pearce, Whitehead & Law, 2015). Scholder (2008) estimates the effect of maternal employment on children's weight using the National Child Development Study, so a cohort of children born in 1958. The study finds that full-time maternal employment during mid-childhood positively affects the probability of overweight at age 16. There is no evidence that part- or full-time employment at earlier/later ages affects this probability, though her study sample grew up in a different environment to today's generation.

Several papers discuss theoretical mechanisms through which increased employment may affect children's weight, but very few assess them empirically (see Anderson (2012) for a review). The main channels associated with higher weight include less time allocated to housework (including meal preparation), a reduction in maternal supervision affecting children's food intake and/or physical activity; on the other hand, increased family income can facilitate healthier life styles and thereby healthier weights (Wake et al., 2009; Wang, Patterson, & Hills, 2002).

Empirical evidence on the importance of these mechanisms is mostly confined to the US, and evidence is non-conclusive. Fertig et al. (2009) explore how maternal employment affects obesity using children's time diaries in the PSID, without obtaining any strong findings. Morrissey et al. (2011), using the National Institute of Child Health and Human Development Study of Early Child Care and Youth Development, also find no significant effects of maternal employment on children's TV watching and physical activity. Crepinsek, Burstein and Associates (2004) find no impact of maternal employment on children's physical activity, though Cawley and Liu (2007) find that employed mothers spend less time playing with their children. Anderson (2012) find that maternal work hours are negatively associated with routines such as eating family meals, or having rules about hours of television. Gwozdz et al. (2013), based on eight European countries, finds little evidence of associations between maternal employment and the mechanisms at play. In the UK, to our knowledge, Hawkins, Cole, and Law (2009) is the only study exploring mechanisms. Looking at five year-olds in the Millennium Cohort Study, they find that children with working mothers are more likely to consume sweetened drinks, use the TV/computer at least 2 h per day, be driven to school, and eat less fruit and vegetables. Overall, the evidence points to inferior food choices amongst working mothers as the more dominant mechanism at play, though evidence is scant and mainly confined to the US.

3. Data

We examine the effect of maternal employment on children's weight using the UK Millennium Cohort Study (MCS), an ongoing longitudinal study following a representative sample of 19,244 families born between 2000 and 2002 in the UK (Joshi & Fitzsimons, 2016). Families were first assessed when children were 9 months old, and followed up at ages 3, 5, 7, 11 and 14. 61% of the initial respondents were in the study at the sixth sweep, though attrition is not absorbing (i.e. individuals can and do return to the study after dropout). Weights are used to adjust for inter-sweep attrition and survey design (Mostafa & Wiggins, 2015).

In each sweep, an interview is carried out with the main parent (normally the mother), resident partners, and, since age 7, with the cohort member. Each sweep contains information on the family, including: parental education; employment and income; housing; family structure; ethnicity; parenting activities such as reading to child; developmental indicators; parental relationship status; and parental

mental health. Weight and height have been measured by trained interviewers at each sweep since age 3.

3.1. Sample selection

The analytic sample was derived from the second sweep of MCS (respondent age 3), which is the first time anthropometric measures were collected in the study. Of the 15,382 singletons interviewed at age 3, 14,109 (91.7%) had valid measures of BMI. Twins and triplets (1.33% of the sample) are excluded to avoid the problem of non-independence of observations. We further selected participants including only those with valid measures of BMI at each sweep, resulting in 7894 observations. We use inverse probability weights to account for non-random attrition from the sample (Mostafa & Wiggins, 2015; Wooldridge, 2007).

3.2. Measures

3.2.1. Child BMI

BMI is calculated by dividing weight in kilograms by squared height in metres. We standardize BMI by age and sex according to the 1990 UK Growth Reference, based on population reference curves derived from around 30,000 BMI measurements from 11 different sources in England, Scotland and Wales collected between 1978 and 1990 (Cole, Freeman and Preece, 1995).

3.2.2. Maternal employment

A mother was defined to be employed if she reported having been in work in the last week, or if she had a job and did not work in the past week for reasons other than parental leave.[3] Mothers who were not classified as employed were defined "not working"; for those employed, we defined part-time employment as between 1 and 34 h, and full-time employment as 35 hours or more.

3.2.3. Single status

A mother was defined as single if she was the only parent living in the household. An alternative was to use marital status, but this is less indicative of who else is living in the household, whilst single status captures one-parent households. However, we control for marital status in the analysis.[4] For simplicity, we refer to mothers who are the only parent in the household as "single", and "partnered" to identify those who are not the only parent in household.

3.2.4. Mechanisms

Excess weight reflects an imbalance between energy expenditure and energy intake. To explore mechanisms, we use measures that are consistently collected from childhood through age 14, and therefore comparable over time. Energy expenditure is proxied using data on sedentary behavior, measured since age 3 by TV watching exceeding three hours per weekday during term-time. Whilst there is information on nutritional intake, including consumption of sweet drinks, fruit, and readymade meals, we do not have consistent measures across sweeps. For this reason, we use a measure of health eating behaviors, collected since age 5, regarding whether or not the child has a regular breakfast every weekday. Each of these variables is parent-reported at ages prior to 14; and child-reported at 14.

3.2.5. Covariates

We distinguish between time-invariant variables, included only in OLS models, and time-varying variables included in OLS and fixed effect models. Time invariant confounders include child ethnicity, maternal education and time of survey. Time varying confounders include father's employment - both a dummy variable for whether or not he works, and hours worked as a continuous measure. Household income was measured using a survey-derived variable on equivalised weekly net family income (Hansen, Johnson, & Joshi, 2012).[5] By controlling for income, the estimated effect of employment is capturing the labour supply time use effect, net of income. Results from a specification in which we do not control for income are similar. We also control for grandparent(s) living in the household, and number of siblings of the cohort member.

To mitigate concerns around time-varying unobserved factors affecting maternal employment and children's weight, we control for the following at each sweep: maternal physical health, captured by self-rated health (good health = excellent, good and very good; and poor health = fair and poor), and self-reported longstanding illness/disability (yes/no); maternal mental health, measured using the Kessler scale, and ranging from 0 to 24; marital status; child's general health on a binary scale (good and poor health).[6]

4. Methodology

The equation we estimate is

$$y_{ijt} = \beta_0 + \beta_1 E_{jt} + X'_{ijt}\beta_2 + f_j + \delta_t + u_{ijt} \quad (1)$$

where i denotes the cohort member; j denotes the household; t denotes time (t = 1 denotes age 3/survey 2…t = 5 denotes age 14/survey 6); y_{ijt} is a measure of weight (BMI); E_{jt} denotes maternal employment at time t. X_{ijt} is a vector of observed time-varying child and household characteristics, including those described above. f_j is a household fixed effect capturing unobserved time-invariant household characteristics[7]; δ_t is a survey-round dummy; and u_{ijt} is an error term assumed to be independent and identically distributed.

The empirical challenge is that household unobserved characteristics (such as genetic or environmental influences), represented by f_j in Eq. (1), may be associated both with maternal employment and children's weight. Mothers in employment are likely to be different from those not in employment. Such differences, rather than employment, could be influencing child outcomes. We use household fixed effects to deal with time invariant unobserved confounding factors. The model is identified under the assumption that no time-varying unobserved variables affect both changes in maternal work status over time and changes in child's BMI. This assumption would be violated if, for instance, serious illness of the mother affected her ability to work and also her ability to engage in household production, which may affect children's weight. To mitigate this issue, we control for key time-varying measures including maternal and child health/illness, and maternal depression, thereby strengthening the assumption of conditional exogeneity of maternal employment.

5. Results

5.1. Descriptives

Table 1 displays patterns of maternal and paternal employment at each sweep of data collection. Around 50% of mothers worked when

[3] Those on parental leave were categorised as not working.

[4] Amongst those who are 'single' (the only parent living in the household), 5.9% report being married/cohabiting at sweep 2. Proportions fluctuate from 6% to 8.4% across sweeps.

[5] Modified OECD scales for equivalisation are used. Each scale sets the family's needs relative to those of a couple with no children, whose scale is set equal to 1. In the modified OECD scale, a family of one parent and one child under 14 has a scale of 0.87; one parent and two such children 1.07; and so on.

[6] At ages 3, 5 and 7, child's health is rated by the parent, and at ages 11 and 14 general health is self-reported.

[7] As there is one child and mother per household, the household fixed effects absorb time-invariant child and maternal characteristics.

Table 1
Parental working profile and partnership status.

		3 years	5 years	7 years	11 years	14 years
Mothers not working	%	50.7	44.9	38.9	33	26.6
	(95% CI)	(49.5; 51.8)	(43.8; 46)	(37.9; 40)	(32; 34.1)	(25.6; 27.6)
Mothers working PT	%	39.3	43.5	46.9	49.1	48.3
	(95% CI)	(38.2; 40.3)	(42.4; 44.6)	(45.8; 48.1)	(48; 50.2)	(47.2; 49.4)
Mothers working FT	%	10.1	11.6	14.1	17.9	25.1
	(95% CI)	(9.4; 10.8)	(10.9; 12.3)	(13.3; 14.9)	(17; 18.8)	(24.2; 26.1)
Single mothers	%	16.5	19	20.3	23.8	24.5
	(95% CI)	(15.7; 17.3)	(18.1; 19.8)	(19.4; 21.2)	(22.8; 24.7)	(23.5; 25.5)
Fathers not working	%	10.5	10.4	10.3	12	10.1
	(95% CI)	(9.7; 11.3)	(9.7; 11.2)	(9.6; 11.1)	(11.2; 12.9)	(9.3; 10.9)
Fathers working PT	%	6.1	6.5	6.9	8.5	8.8
	(95% CI)	(5.5; 6.7)	(5.9; 7.1)	(6.2; 7.5)	(7.8; 9.2)	(8.1; 9.6)
Fathers working FT	%	83.4	83.1	82.8	79.5	81.1
	(95% CI)	(82.5; 84.4)	(82.1; 84)	(81.8; 83.7)	(78.5; 80.6)	(80; 82.1)
Weekly hours for mothers in employment	mean	23.2	23.5	24.3	25.9	28
	(s.e.)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)
Weekly hours for fathers in employment	mean	44.1	42.7	42.9	43.5	43.1
	(s.e.)	(0.15)	(0.14)	(0.15)	(0.16)	(0.16)
Both parents working	%	50.7	56.4	62.4	66	72.6
	95% CI	(49.5; 52)	(55.2; 57.7)	(61.1; 63.6)	(64.8; 67.2)	(71.4; 73.8)

Table 2
BMI and prevalence of overweight/obesity based on UK90 cut-offs, for overall sample and by gender.

		3 years	5 years	7 years	11 years	14 years
Full sample	N	7894	7894	7894	7894	7894
	BMI Mean (SD)	16.3 (1.57)	16.2 (1.55)	16.5 (2.18)	19.1 (3.45)	21.4 (4.09)
	% Overweight/obese (95% CI)	20.2 (19.3; 21.1)	24.0 (23; 24.9)	22.2 (21.3; 23.2)	34.0 (33; 35.1)	34.2 (33.2; 35.3)
Females	N	3964	3964	3964	3964	3964
	BMI Mean (SD)	16.2 (1.59)	16.2 (1.66)	16.5 (2.22)	19.3 (3.54)	22.0 (4.16)
	% Overweight/obese (95% CI)	18.2 (17.0; 19.4)	21.2 (19.9; 22.5)	20.6 (19.4; 21.9)	32.0 (30.5; 33.4)	35.7 (34.2; 37.2)
Males	N	3930	3930	3930	3930	3930
	BMI Mean (SD)	16.5 (1.55)	16.3 (1.64)	16.5 (2.13)	18.9 (3.52)	20.9 (3.94)
	% Overweight/obese (95% CI)	22.2 (20.9; 23.5)	26.6 (25.2; 28)	23.8 (22.4; 25.1)	36.0 (34.5; 37.5)	32.9 (31.4; 34.3)

Notes: In order to make estimates of continuous BMI interpretable, they are not age and gender standardised. Proportions of overweight and obesity are based on standardised estimates.

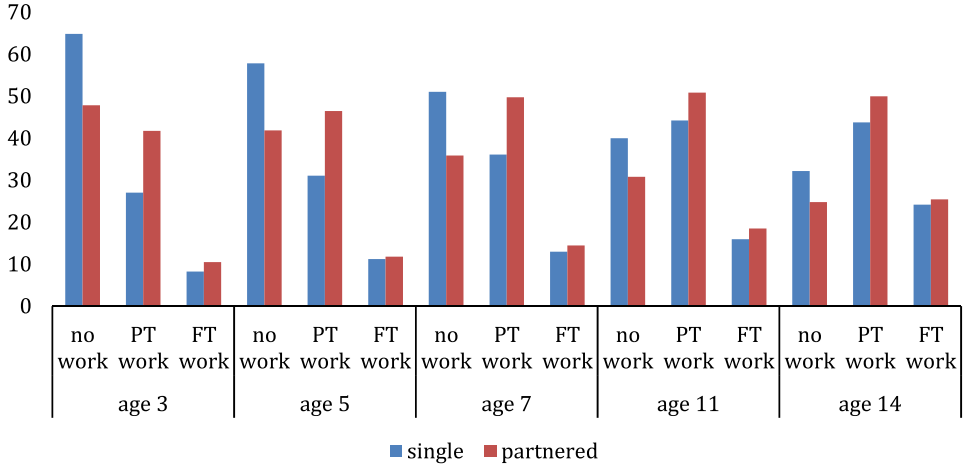

Fig. 1. Proportions of maternal employment by single/partnered status and sweep.

Table 3
Characteristics of mothers at baseline (sweep 2), by partnership and working status.

	Not working		Working PT		Working FT	
	Single (N[a] = 600)	Couple (N[a] = 3119)	Single (N[a] = 258)	Couple (N[a] = 2872)	Single (N[a] = 102)	Couple (N[a] = 861)
Age at sweep 2	27.8 (6.3)	31.5 (5.68)	29.9 (6.44)	33.1 (5.18)	30.5 (6.15)	33.6 (5.32)
% A level or higher qualification	6.7 (24.97)	23.3 (42.29)	13.9 (34.62)	38.6 (48.69)	28.4 (45.33)	49.2 (50.02)
% Married	4.4 (20.61)	74.4 (43.63)	5.5 (22.86)	79.3 (40.53)	9.4 (29.35)	77.7 (41.66)
Depression (Kessler scale 0–24)	5 (4.89)	3.5 (3.94)	3.7 (3.63)	2.7 (3.04)	3.8 (3.85)	2.6 (2.79)
% with long-lasting physical illness	29.1 (45.47)	24.5 (43)	24.3 (42.96)	19.1 (39.33)	21.9 (41.58)	19.3 (39.52)
% poor self-rated health	27.9 (44.9)	17.5 (38.02)	19 (39.32)	10.2 (30.28)	18.2 (38.81)	11.5 (31.89)
% Grandparent(s) living in HH	5.9 (23.67)	3.5 (18.27)	13.3 (34.01)	1.7 (12.76)	14.3 (35.2)	4.8 (21.3)
Number of siblings of CM in HH	1.2 (1.21)	1.5 (1.1)	0.8 (0.98)	1 (0.87)	0.6 (0.99)	0.8 (0.82)
Weekly net family income	127.1 (63.08)	457.4 (311.06)	211.5 (104.32)	587.7 (300.58)	319 (142.04)	722.8 (361.55)

Notes: HH = household; CM = core-member (i.e. child)
Descriptive statistics weighted, sample sizes N unweighted.
Standard deviations in parentheses.
[a] Descriptive statistics may have lower sample sizes due to unit non-response.

Table 4
OLS and FE linear probability models, dependent variable BMI.

VARIABLES		OLS		FE	
		β	S.E.	β	S.E.
Mother Part Time (1–34 h)		0.022	(0.0137)	0.072***	(0.0177)
Mother Full Time (35+ h)		0.110***	(0.0185)	0.110***	(0.0249)
Single mother		0.066***	(0.0234)	0.093***	(0.0307)
Father works		-0.104***	(0.0363)	0.006	(0.0501)
Hours father works		0.002**	(0.0007)	0.000	(0.0009)
HH income (£ thousands)		-0.001***	(0.0001)	0.000***	(0.0000)
Grandparents in HH		0.102***	(0.0298)	-0.105**	(0.0423)
# siblings		-0.016***	(0.0057)	-0.001	(0.0123)
Mother long lasting illness		0.005	(0.0144)	0.021	(0.0179)
Mother poor heath		0.088***	(0.0180)	0.024	(0.0210)
Mother depression		-0.003*	(0.0016)	-0.002	(0.0017)
Marital status (married/cohabiting)		-0.026*	(0.0159)	-0.003	(0.0225)
CM poor health		0.110***	(0.0164)	0.058***	(0.0176)
Ethnicity	Mixed	-0.315***	(0.0586)		
	Indian	-0.320***	(0.0411)		
	Pakistani and Bangladeshi	-0.178***	(0.0318)		
	Black or Black British	0.438***	(0.0353)		
	Other	-0.166***	(0.0481)		
Mother's Education	GCSE D-G w/ voc > =L3	0.030	(0.0246)		
	Voc > =3 + GCSE D-C or less	0.183***	(0.0292)		
	GCSE A-C & A lev w/ voc > =L3	0.047***	(0.0178)		
	A lev + voc > = L3 & diploma HE	-9.15E-05	(0.0234)		
	Degree	-0.091***	(0.0229)		
	Higher degree	-0.000	(0.0362)		
Age 5		0.216***	(0.0180)		
Age 7		0.120***	(0.0182)		
Age 11		0.538***	(0.0379)		
Age 14		0.363***	(0.0187)		
Observations		39,470		39470	

Notes: PT = part time; FT = full time; HH = household; Voc = vocational classification; HE = higher education.
Standard errors in parentheses.
* denote statistical significance at 1% levels respectively.
** denote statistical significance at 5% levels respectively.
*** denote statistical significance at 10% levels respectively.

Table 5
OLS and FE linear probability models, interaction between maternal employment and single status. Dependent variable BMI.

VARIABLES		OLS		FE	
		β	S.E.	β	S.E.
Single mother not working		0.058**	(0.0279)	0.033	(0.0387)
Single mother works PT		0.046*	(0.0279)	0.186***	(0.0381)
Single mother works FT		0.103***	(0.0377)	0.243***	(0.0550)
Couple mother works PT		0.016	(0.0153)	0.049***	(0.0186)
Couple mother works FT		0.111***	(0.0206)	0.078***	(0.0247)
Father works		-0.102***	(0.0364)	0.013	(0.0505)
Hrs father works		0.002**	(0.0007)	0.001	(0.0009)
HH income (in thousands)		-0.001***	(0.0001)	0.000***	(0)
Grandparents in HH		0.101***	(0.0299)	-0.107**	(0.0424)
# siblings		-0.016***	(0.0057)	-0.002	(0.0123)
Mother long lasting illness		0.005	(0.0144)	0.022	(0.0179)
Mother poor heath		0.088***	(0.018)	0.025	(0.021)
Mother Depression		-0.003*	(0.0016)	-0.002	(0.0017)
Marital status (married/cohabiting)		-0.025	(0.0159)	0.002	(0.0225)
CM poor health		0.110***	(0.0164)	0.058***	(0.0175)
Ethnicity	Mixed	-0.314***	(0.0587)		
	Indian	-0.322***	(0.0411)		
	Pakistani and Bangladeshi	-0.179***	(0.0319)		
	Black or Black British	0.437***	(0.0353)		
	Other	-0.167***	(0.0481)		
Mother's Education	GCSE D-G w/ voc > =L3	0.031	(0.0246)		
	voc > =3 + GCSE D-C or less	0.183***	(0.0292)		
	GCSE A-C & A lev w/ voc > =L3	0.046***	(0.0178)		
	A lev + voc > = L3 & diplomas in HE	0.000	(0.0234)		
	Degree	-0.091***	(0.0229)		
	Higher degree	-0.001	(0.0362)		
Age 5		0.216***	(0.018)		
Age 7		0.119***	(0.0182)		
Age 11		0.537***	(0.0379)		
Age 14		0.362***	(0.0187)		
Observations		39,470		39,470	

Notes: PT = part time; FT = full time; HH = household; Voc = vocational classification; HE = higher education.
Standard errors in parentheses.
* denote statistical significance at 1% levels respectively.
** denote statistical significance at 5% levels respectively.
*** denote statistical significance at 10% levels respectively.

Table 6
OLS and FE linear probability models. 2-parents households only (N = 7,374). Dependent variable BMI.

VARIABLES		OLS		FE	
		β	S.E.	β	S.E.
Mother Part Time (1–34 h)		0.041	(0.0286)	0.045	(0.0343)
Mother Full Time (35+ h)		0.145***	(0.0314)	0.077**	(0.0384)
Father Part Time (1–34 h)		-0.044	(0.0348)	0.033	(0.0446)
Father Full Time (35+ h)		-0.022	(0.0267)	-0.003	(0.0412)
Both parents work (ref. No)		-0.023	(0.0312)	-0.003	(0.0373)
HH income (£ thousands)		-0.001***	(0.0001)	0.000***	(0.0000)
Grandpa in HH		0.163***	(0.0367)	-0.086	(0.0527)
# siblings		0.003	(0.0065)	-0.003	(0.0144)
Marital status (married/cohabiting)		-0.022	(0.0164)	0.049*	(0.0268)
Mother long lasting illness		-0.01	(0.0159)	-0.008	(0.0196)
Mother poor heath		0.103***	(0.0207)	0.013	(0.0233)
Mother depression		-0.004**	-0.0018	-0.002	(0.0018)
CM poor health		0.103***	(0.0185)	0.027	(0.0181)
Ethnicity	Mixed	-0.245***	(0.0765)		
	Indian	-0.318***	(0.0422)		
	Pakistani and Bangladeshi	-0.228***	(0.0341)		
	Black or Black British	0.410***	(0.0467)		
	Other	-0.265***	(0.0509)		
Mother's education	GCSE D-G w/ voc > =L3	0.094***	(0.0290)		
	voc > =3 + GCSE D-C or less	0.154***	(0.0336)		
	GCSE A-C & A lev w/ voc > =L3	0.042**	(0.0207)		
	A lev + voc > = L3 & diplomas in HE	0.019	(0.0258)		
	Degree	-0.093***	(0.0250)		
	Higher degree	0.000	(0.0377)		
Age 5		0.205***	(0.0192)		
Age 7		0.092***	(0.0195)		
Age 11		0.495***	(0.0439)		
Age 14		0.310***	(0.0203)		
Observations		32,484		32,484	

their child was age 3, rising to 73% by child age 14. Among mothers in employment, the percentage working full time (≥ 35 hours) increases as the child ages; proportions in part-time employment also rise over time but by less. This pattern of increasing maternal employment over childhood is commonly observed. For instance in the US in 2008, 59.6% of mothers of children aged 0–3 were employed, 63.6% of mothers with children under age 6, and 77.5% of those whose youngest child is aged 6–17 years old (Bureau of Labor Statistics, 2009). The proportion of single mothers increases over childhood, from 16.5% at child age 3 to 24.5% ten years later.

Turning to father's employment, the patterns are noticeably different. Proportions in different employment categories remain relatively stable over childhood – with around 10% not working, 80% working full-time, and the remainder working part-time. Average hours worked per week are also lower on average amongst mothers in employment than fathers. Finally, the proportion of households with both parents working gradually increases from ages 3 to 14, from 50.7% to 72.6%, mainly driven by increased labour force participation of mothers over childhood.

Table 2 shows average BMI values, alongside the prevalence of overweight/obesity, by age, both overall and by gender. BMI increases with age, among both females and males. The proportion of overweight and obesity fluctuates between 20% and 24% from age 3 to 7, and rises starkly to 34% at age 11, where it remains stable to age 14 (see Pongiglione and Fitzsimons (2017)). No stark gender differences in trends are observed.

Fig. 1 shows how maternal employment varies by sweep, by whether the mother is single or in a partnership. The trends for single mothers (blue bars) and partnered mothers (red bars) are similar in showing declining proportions of mothers not in employment, and increasing proportions of mothers working full-time across childhood. Whilst the proportions in full-time employment are similar across both, the proportions not in employment are higher among single mothers, with a greater proportion of partnered mothers in part-time employment.

In Table 3, we compare socio-demographic characteristics at baseline (i.e. sweep 2/age 3) of single and partnered mothers, separately by employment status. Across each type of employment status, the largest differences between single and partnered mothers are in education level and household income, with single mothers having lower levels of both. Another striking difference is that single mothers in employment are more likely to live with their parents, and figures are very similar for part- and full-time (13.3% and 14.3% respectively); corresponding figures for partnered mothers are 1.7% and 4.8%. We also see that depressive symptoms are higher amongst single mothers, and particularly amongst those not in employment.

5.2. Main findings

Table 4 presents the main findings, showing OLS alongside fixed effects estimates. Looking first at part-time employment, we see that its effect on children's BMI, as estimated in our preferred fixed effects specification, is 0.07 of a standard deviation (sd); the OLS estimate is smaller, at 0.02, and not significant. This downward bias in the OLS estimates of part-time employment likely reflects the fact that mothers in work, who typically have higher levels of education than those not in employment, have unobserved time-invariant preferences which also tend to decrease children's BMI. If we omit these, the resulting OLS estimate is downward biased. The corresponding coefficient for full-time employment is 0.0.11sd, which is the same as the OLS estimate in this case).

Amongst other regressors in the model, we see that the coefficient estimate as to whether the father works is negative and significant in the OLS models, whilst the coefficient on hours is positive, though very close to zero. However the fixed effects estimates, which adjust for selection on time-invariant unobservables, are not statistically different from zero. The relationship with resident grandparents is noteworthy. Its association with children's BMI is positive and statistically significant (0.102), compared to a negative effect on BMI of 0.105 in the fixed effects model. We come back to this in Section 6. We also highlight the inclusion of extensive health-related variables at each sweep - maternal physical health, maternal mental health, and child physical health at all observed ages in the study – to mitigate concerns around unobserved time varying shocks affecting both maternal employment and children's weight. Child physical health is the most strongly associated, with children with poor health having higher BMI. Finally, in Table A1 of the Appendix, we show a specification in which we do not control for income; employment effects are very similar, suggesting that the income effect is not an important mechanism.

We next assess whether the effects of maternal employment vary depending on whether the mother is single or in a partnership. We

Table 7
FE linear probability models, dependent variables inactivity (TV), healthy eating (regular breakfast).

Variables	Calories expenditure **Inactivity** (watch TV 3+ h per weekday)				Healthy eating behavior **Breakfast** (having breakfast every day)			
	(1)		(2)		(3)		(4)	
	β	S.E.	β	S.E.	β	S.E.	β	S.E.
Mother works PT	0.049***	(0.0086)			-0.107***	(0.0113)		
Mother works FT	0.135***	(0.0125)			-0.205***	(0.0148)		
Single mother not-working	0.028*	(0.0158)	0.014	(0.0204)	-0.053***	(0.0178)	-0.004	(0.023)
Single mother works PT			0.074***	(0.0198)			-0.168***	(0.0232)
Single mother works FT			0.185***	(0.0263)			-0.287***	(0.0295)
Couple mother works PT			0.044***	(0.0088)			-0.089***	(0.0117)
Couple mother works FT			0.123***	(0.0127)			-0.175***	(0.0152)
Father works	-0.017	(0.0238)	-0.015	(0.0239)	0.017	(0.0256)	0.012	(0.0255)
Hrs father works	0.000	(0.0004)	0.000	(0.0004)	-0.001**	(0.0005)	-0.001**	(0.0005)
HH income (£ thousands)	-0.000199***	(0.0000)	-0.000199***	(0.0000)	0.000259***	(0.0000)	0.000259***	(0.0000)
Grandparents in HH	-0.060***	(0.0192)	-0.059***	(0.0193)	0.113***	(0.023)	0.115***	(0.0228)
# siblings	0.017***	(0.0061)	0.017***	(0.0061)	-0.038***	(0.0085)	-0.038***	(0.0084)
Mother long lasting illness	0.012	(0.0096)	0.012	(0.0096)	-0.013	(0.0103)	-0.0141	(0.0104)
Mother poor heath	0.025**	(0.0119)	0.025**	(0.0119)	-0.036***	(0.0126)	-0.036***	(0.0126)
Mother depression	0.005***	(0.001)	0.005***	(0.001)	-0.004***	(0.0011)	-0.004***	(0.0011)
Mother marital status (married/cohabiting)	-0.012	(0.0124)	-0.010	(0.0124)	-0.038***	(0.0142)	-0.041***	(0.0141)
CM poor health	0.014	(0.0101)	0.014	(0.0101)	-0.054***	(0.0113)	-0.054***	(0.0113)
Observations	39,000		39,000		31,121		31,121	

PT = part time; FT = full time; HH = household; Voc = vocational classification; HE = higher education.
Standard errors in parentheses.
* denote statistical significance at 1% levels respectively.
** denote statistical significance at 5% levels respectively.
*** denote statistical significance at 10% levels respectively.

include an interaction between mother's partnership status and her employment status (part-/full-time). When we do this, some striking differences emerge, shown in Table 5. Focusing on our preferred specification, the fixed effects model, we see that the adverse effect of maternal employment on children's BMI is particularly pronounced for single mothers working full-time (0.24sd), with significant and slightly lower effects for part-time employment of single mothers (0.19sd). Turning to mothers in partnerships, the effects of employment on children's BMI are significantly lower than for single mothers but still evident, at 0.05sd (part-time) and 0.08sd (full-time). The table reaffirms the large downward bias in the OLS estimates (shown in the first two columns). As before, we find that the relationship with paternal employment is not statistically significant in the fixed effects models.

Finally, we estimate a specification in which we restrict the sample to two-parent households. This is to understand the effect of combined parental employment on children's BMI. We consider separately maternal and paternal employment (full- and part-time), and also include a dummy variable which takes the value one if both parents are working (either part- or full-time). In Table 6, we find a significant positive association between maternal full-time employment and children's BMI in this set-up, and whilst the OLS estimate is larger, it is not significantly different from the FE estimate. We find no evidence of both parents working having any additional detrimental effect. However this is largely to be expected in our sample, given that the vast majority of fathers are in employment, and we are not adding much additional variation to our measure.

5.3. Mechanisms

In this section we explore the potential mechanisms, outlined in previous sections, underlying the strong adverse effects of maternal employment on children's BMI, particularly for single mothers. As noted already, we control for income in our main specification, thereby ruling out the income effect of labour supply. The two mechanisms we explore here relate to healthy eating behavior and energy expenditure.

Table 7 shows results from FE models (OLS models are presented in Table A2 of the appendix). We see that compared to children whose mothers are not in employment, those whose mothers work part-time are around 5 percentage points more likely to watch TV for more than three hours per day, whilst the figure is around 14 percentage points for those whose mothers are in full-time employment (column 1). Looking at healthy eating behaviors (column 3), we see that children whose mothers are in part- or full-time employment are respectively 11 percentage points (ppt) and 21 ppt less likely to have a regular breakfast compared to children whose mothers are not in employment. These findings of adverse effects of maternal employment on energy expenditure and healthy eating behaviors, particularly for full-time employment, are consistent with BMI increasing in maternal employment.

When we estimate the effects separately by partnership status, shown in columns (2) and (4) of Table 7, we find that the effects on both health eating habits (likelihood of regular breakfast) and inactivity (likelihood of watching TV for more than 3 h per day) are most adverse for mothers in full-time employment. This is especially the case for single mothers, whose children are almost 19 ppt more likely to have sedentary behavior and 29 ppt less likely to eat regular breakfast. This is consistent with the effects of employment and partnership on BMI observed in Table 5. For mothers in part-time employment, we also observe adverse effects on both sedentary behavior and healthy eating habits, and, as for full-time employment, the disadvantage is larger for single mothers. Finally, among mothers not working, no differences were found between those single and those in a partnership. behavior.

Regarding fathers, we find no relationship between paternal

employment and children's sedentary and healthy eating behaviors, consistent with findings in Tables 4 and 5 (the point estimate for breakfast, though significant for father's hours of work, is extremely small in magnitude). behaviorAnother noteworthy finding, which helps shed some light on the underlying mechanisms, is the effect of living with grandparents. In Table 4, we observed that having resident grandparents in the household reduces children's BMI. Table 7 shows that children with grandparents in the household are less likely than those without grandparents present to be sedentary, and more likely to have breakfast every day. This is consistent with children's BMI being lower in these households, and indicates potential substitution of maternal time and inputs by grandparents.

6. Discussion

The findings in this paper, based on fixed effects estimates from rich longitudinal data collected in the UK, show that maternal employment during childhood increases children's BMI. Our analysis highlights the importance of distinguishing between different family types. In particular, the adverse effects on BMI are considerably larger for single mothers in employment, whether part- or full-time. Smaller, though significant effects, are found for maternal employment amongst those in a partnership.

Investigating potential mechanisms, we find that children whose mothers work are more likely to have increased sedentary behavior and poorer dietary habits. This is consistent with the positive relationship between maternal employment and children's BMI.

Whilst the focus of the investigation was on maternal labour supply, we acknowledge that paternal employment is an extremely important and inter-related consideration: household labour supply is a joint decision-making process, and modelling it is beyond the scope of this paper though an important avenue for future work. We controlled for father's labour supply throughout our analysis and did not find any significant effect on children's BMI. However, in our context, the vast majority of fathers are in employment, with most working full-time hours. So compared to mothers, variation in paternal labour supply is more limited, making identification of effects more challenging. This finding and interpretation is consistent with previous work (Ziol-Guest, Dunifon, & Kalil, 2013).

Interesting findings emerged in relation to grandparents, where we find some suggestive evidence that the presence of grandparents in the household is beneficial to children's BMI, and that children whose grandparents live with them are less likely to be sedentary, and more likely to have healthy eating habits, captured by having breakfast every day. These findings highlight the need for further research into the intra-household allocation of time and inputs, particularly in relation to children's health and healthy behaviors.

Whilst our study has several strengths, we note some limitations. First, selection into maternal employment is dealt with using household fixed effects. If there are time-varying unobservables correlated with maternal employment and children's BMI, our estimates will be biased. Whilst we mitigate this concern by controlling for several time-varying child and maternal health indicators, it cannot be completely ruled out. Second, we do not consider work patterns such as non-standard shifts or the timing of labour supply over childhood, for either of mothers or fathers, which is an important topic for future research. However, our results are consistent with previous work suggesting that maternal employment is associated with higher BMI of children.

The findings from this research have several policy implications and need to be interpreted and transmitted cautiously. The fact that maternal employment has a detrimental effect on children's BMI, while paternal employment does not appear to be relevant, is suggestive of differing workload and childcare responsibilities between parents. The beneficial effect of grandparents living in household indicates a positive impact of adult supervision on children's behavior and health-related outcomes. Given that female participation in the labour market has steadily increased over the last half century, and trends are not expected to change, involving fathers as active players in efforts to tackle the high rates of childhood excess weight and to promote children's health and wellbeing seem to be a fundamental step. A recent study by Davison et al. (2018) examined the representation of fathers in family interventions to prevent childhood obesity in the last decade, finding that of the 61 interventions in which parents' gender was identified, 31 (51%) included both parents, 29 (47.4%) included only mothers, 1 (1.6%) included only fathers. Programmes encouraging healthy behaviors among children could be better tailored to bring both parents on board, and to consider changes in family structures, with an increasing prevalence of single-mother households and households with mothers working full-time. The other important stakeholder in childhood obesity prevention are schools. Preschool childcare settings are used by a growing number of families for extended periods each day, and hence will be increasingly central for promoting early healthy behaviors.

Ethical approval statement

This is to state that the UK Millennium Cohort Study has received ethical approval from the National Health Service (NHS) Research Ethics Committee (REC) system. Ethical approval has been sought for all MCS surveys since the start of the study in 1999.

Emla Fitzsimons, UCL Institute of Education.

Conflict of interest statement

Emla Fitzsimons is the Principal Investigator of the Millennium Cohort Study, but declares no conflict of interest in relation to this work. There are no financial conflicts of interest.

Role of the funding source

We are grateful to the Centre for Longitudinal Studies, UCL Institute of Education, for the use of these data and to the UK Data Service for making them available. However, they bear no responsibility for the analysis or interpretation of these data. We acknowledge funding from the ESRC (grant number ES/M008584/1) as part of the Cross-cohort Research Programme. The sponsor had no role in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Appendix A

See Appendix Tables A1 and A2.

Table A1
OLS and FE linear probability models, dependent variable BMI – no income.

VARIABLES		OLS		FE	
		β	S.E.	β	S.E.
Mother Part Time (1–34 h)		0.017	(0.0137)	0.083***	(0.0178)
Mother Full Time (35+ h)		0.102***	(0.0185)	0.127***	(0.0251)
Single mother		0.071***	(0.0234)	0.109***	(0.0309)
Father works		-0.108***	(0.0363)	-0.004	(0.0502)
Hrs father works		0.001**	(0.0007)	0.001	(0.0009)
Grandparents in HH		0.103***	(0.0299)	-0.113***	(0.0427)
# siblings		-0.011*	(0.0057)	0.007	(0.0124)
Mother long lasting illness		0.004	(0.0144)	0.014	(0.0179)
Mother poor heath		0.088***	(0.018)	0.022	(0.0211)
Mother Depression		-0.002	(0.0016)	-0.002	(0.0017)
Marital status (married/cohabiting)		-0.030*	(0.0159)	0.001	(0.0226)
CM poor health		0.112***	(0.0164)	0.054***	(0.0176)
Ethnicity	Mixed	-0.311***	(0.0587)		
	Indian	-0.315***	(0.0411)		
	Pakistani and Bangladeshi	-0.168***	(0.0318)		
	Black or Black British	0.442***	(0.0353)		
	Other	-0.162***	(0.0481)		
Mother's Education	GCSE D-G w/ voc > =L3	0.031	(0.0246)		
	Voc > =3 + GCSE D-C or less	0.182***	(0.0292)		
	GCSE A-C & A lev w/ voc > =L3	0.040**	(0.0177)		
	A lev + voc > = L3 & diploma HE	-0.019	(0.0232)		
	Degree	-0.115***	(0.0226)		
	Higher degree	-0.035	(0.0358)		
Age 5		0.214***	(0.018)		
Age 7		0.117***	(0.0182)		
Age 11		0.320***	(0.0185)		
Age 14		0.361***	(0.0186)		
Observations		39470		39470	
Number of unique observations				7894	

PT = part time; FT = full time; HH = household; Voc = vocational classification; HE = higher education.
Standard errors in parentheses.
* denote statistical significance at 1%levels respectively.
** denote statistical significance at 5% levels respectively.
*** denote statistical significance at 10% levels respectively.

Table A2
Linear probability models, dependent variables inactivity (watch TV) and health eating (regular breakfast).

VARIABLES		Calories expenditure **Inactivity** (watch TV 3+ h per weekday)				Healthy eating behaviour **Breakfast** (having breakfast every day)			
		β	S.E.	β	S.E.	β	S.E.	β	S.E.
Mother works PT		-0.001	(0.0048)			-0.004	(0.0049)		
Mother works FT		0.012*	(0.0066)			-0.018***	(0.0064)		
Single mother not working		0.013	(0.0083)	0.024**	(0.0099)	-0.035***	(0.0082)	-0.025**	(0.0099)
Single mother works PT				0.007	(0.0106)			-0.042***	(0.0103)
Single mother works FT				0.022	(0.0138)			-0.062***	(0.0131)
Couple mother works PT				0.004	(0.0054)			-0.0008	(0.0055)
Couple mother works FT				0.016**	(0.0073)			-0.011	(0.0072)
Father works		-0.013	(0.0129)	-0.015	(0.0129)	0.016	(0.0127)	0.014	(0.0127)
Hrs father works		-0.001***	(0.0002)	-0.0006***	(0.0002)	-0.0003	(0.0002)	-0.0003	(0.0002)
HH income (in thousands)		0.0001***	(0)	0.0001***	(0)	8.10e-05**	(0)	8.23e-05**	(0)
Grandparents in HH		-0.011	(0.0106)	-0.01	(0.0106)	0.004	(0.0104)	0.004	(0.0104)
# siblings		0.004**	(0.002)	0.004**	(0.002)	-0.008***	(0.002)	-0.008***	(0.002)
Mother's long lasting illness		0.0005	(0.0051)	0.0003	(0.0051)	-0.021***	(0.005)	-0.021***	(0.005)
Mother's poor heath		0.025***	(0.0064)	0.025***	(0.0064)	-0.027***	(0.0064)	-0.027***	(0.0064)
Mother's depression		0.003***	(0.0006)	0.003***	(0.0006)	-0.0008	(0.0005)	-0.001	(0.0005)
Mother's marital status (married)		-0.033***	(0.0056)	-0.033***	(0.0056)	0.026***	(0.0056)	0.025***	(0.0056)
Child's poor health		0.041***	(0.0058)	0.041***	(0.0058)	-0.072***	(0.0058)	-0.072***	(0.0058)
Ethnicity	Mixed	0.049**	(0.0207)	0.048**	(0.0207)	-0.001	(0.0203)	0.0002	(0.0203)
	Indian	-0.004	(0.0146)	-0.004	(0.0146)	0.041***	(0.0144)	0.041***	(0.0144)
	Pakistani and Bangladeshi	-0.032***	(0.0113)	-0.031***	(0.0113)	0.0004	(0.0111)	0.002	(0.0111)
	Black or Black British	0.033***	(0.0125)	0.032***	(0.0125)	-0.028**	(0.0122)	-0.029**	(0.0122)
	Other	0.019	(0.0172)	0.02	(0.0172)	0.040**	(0.017)	0.041**	(0.017)
Mother's Education	GCSE D-G w/ voc > =L3	0.005	(0.0087)	0.006	(0.0087)	0.020**	(0.0086)	0.020**	(0.0086)
	Voc > =3 + GCSE D-C or less	-0.008	(0.0103)	-0.007	(0.0104)	0.011	(0.0101)	0.012	(0.0102)
	GCSE A-C & A lev w/ voc > =L3	-0.055***	(0.0063)	-0.054***	(0.0063)	0.048***	(0.0062)	0.049***	(0.0062)
	A lev + voc > = L3 & diploma HE	-0.091***	(0.0083)	-0.090***	(0.0083)	0.072***	(0.0081)	0.073***	(0.0081)
	Degree	-0.134***	(0.0081)	-0.133***	(0.0081)	0.114***	(0.008)	0.115***	(0.008)
	Higher degree	-0.149***	(0.0128)	-0.149***	(0.0128)	0.121***	(0.0126)	0.121***	(0.0126)
Age 5		-0.035***	(0.0064)	-0.035***	(0.0064)				
Age 7		-0.032***	(0.0064)	-0.033***	(0.0064)	0.008	(0.0056)	0.008	(0.0056)
Age 11		-0.051***	(0.0135)	-0.052***	(0.0135)	-0.072***	(0.0119)	-0.072***	(0.0119)
Age 14		0.247***	(0.0066)	0.247***	(0.0066)	-0.384***	(0.0057)	-0.384***	(0.0057)
Observations		39,000		39,000		31,121		31,121	

PT = part time; FT = full time; HH = household; Voc = vocational classification; HE = higher education.
Standard errors in parentheses.
* denote statistical significance at 1% levels respectively.
** denote statistical significance at 5%levels respectively.
*** denote statistical significance at 10% levels respectively.

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