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Jonathan Briody, University College Dublin

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Parental Unemployment During the Great Recession and Childhood Adiposity☆

Jonathan Briody - School Of Economics, Geary Institute for Public Policy, University College Dublin Belfield, Dublin 4, Ireland

Correspondence

Jonathan Briody, School Of Economics, Geary Institute, University College Dublin, Belfield, Dublin 4, Ireland. Jonathan.Briody@ucdconnect.ie

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Abstract: The incidence of adiposity in the early years of life has outgrown the prevalence rate in older children and adolescents globally; however, the relationships between unemployment and weight are predominantly studied in adults. This study examines the relationship between changing economic conditions during the Irish recession and child weight. Fixed effect logistic regression is used to examine the effects of parental unemployment on weight using the Growing up in Ireland infant cohort from 2008 to 2013. This study is the first to use longitudinal anthropometric measurements to estimate the impact of parental unemployment on children's weight before, during and after a recession. Child growth charts are used to quantify children according to overweight for BMI, weight for age, and weight for height measures. For BMI, the probability of a child being overweight is 6 percentage points higher if either parent has experienced unemployment. For weight for age the probability is of similar magnitude across several alternative growth charts and definitions of adiposity. The analysis is repeated, cross-sectionally, for physical activity and diet to clarify mechanisms of effect. The probability of a child consuming healthy food and physical activity with an implied cost is lower if either parent becomes unemployed. A focus on excess adiposity in the early years is of crucial importance as if current trends are not addressed a generation of children may grow up with a higher level of chronic disease.

JEL Classification: I12, I18, C33, J10, J13

Keywords: Health; Panel data; Unemployment; The Great Recession, Children

1. **Introduction**

Rising childhood weight is set to become one of the largest health challenges of the 21st century, at least one in ten school-aged children are estimated to hold excess weight internationally (Lobstein et al., 2004), and in Ireland, more than 25% are overweight or obese (Keane, Kearney, Perry, Kelleher, & Harrington, 2014; Perry et al., 2017). Excess weight in childhood is associated with the development of chronic diseases such as heart disease, type 2 diabetes, depression, sleep disorders, hypertension and other co-morbidities (Jo, 2018). Yet, the most significant long-term impact occurs when overweight children reach adulthood. Adults who are overweight or obese at a young age have a higher probability of premature mortality but also long-term morbidity (Simmonds et al., 2015).

There is financial cost as well as a health cost to excess child weight, Perry et al. (2017) estimate projected lifetime costs of €4.6 billion attributable to childhood overweight and obesity for Ireland; with the total excess cost per person, discounted to 2015 values, estimated to be €16,036. A 1% reduction in population mean childhood BMI is associated with a €270 million reduction in total lifetime costs, and €1.1 billion for a 5% reduction. Perry et al. (2017) find that 21% of the lifetime costs of childhood overweight and obesity are attributed to direct healthcare costs, and 79% are due to indirect costs.

While the importance of general economic deprivation for child health and development is frequently documented (Aber et al., 1997; Bann et al., 2018), little is known about the impact of the 2008-2009 Great Recession on the prevalence of excess weight in young children. The literature indicates that children's physical development is particularly vulnerable to economic change (Bellés-Obrero et al., 2016). Thus, the widespread economic decline experienced during the most recent crises can be reasonably expected to influence children's weight outcomes (Oddo et al., 2016).This study presents the first estimates of the impact of parental unemployment during the Irish recession on children's weight using longitudinal data representative of the national child population. I then consider whether variations in children's health behaviours are consistent with a parental income or time effect.

Socioeconomic disparities in health are well established, with poorer individuals predominantly reporting poorer health (Ruhm, 2015). However, contradictory findings regarding the impact of economic downturns on physical health characterise the literature. Recessions have been found to both improve (Ruhm, 2005) and disimprove (Dave & Kelly, 2012; Latif, 2014) health behaviours such as smoking, physical activity and diet (Ruhm, 2005). Research predating the 2008 Great Recession finds economic downturns to be associated with weight declines in adults (Ruhm, 2000). Yet little is known about the impact of recessions on childhood weight. There have been no studies to date in Europe, while in the U.S., two studies have found both an increased and a decreased risk of childhood overweight when using aggregate (state) unemployment data (Bellés-Obrero et al., 2016; Oddo et al., 2016).

The main contribution of this study is the provision of evidence on the effect of parental unemployment on a distinct and central component of childhood health, that of adiposity. Although the literature has investigated the influence of recessions on adults' weight and infants' weight at delivery, the effect on young children has not yet been tested.

Within-child estimates are crucial to the causal analysis of weight status (Reichenheim & Coutinho, 2010). However, weight and height are predominantly studied in repeated cross-sectional settings, with few studies exploiting longitudinal data (Bellés-Obrero et al., 2016). This may be due to the unpredictable nature of economic shocks, such that there are very few prospectively gathered individual-level cohort studies which can examine this association with comparable pre- and post-recession data, or the limited number of cohort studies with objective anthropometric measures in young children (Jones et al., 2017; Karanikolos et al., 2013). This study addresses this issue by using large sample detailed panel data which spans the period before, during and after the recession.

Weight is historically under-recorded in surveys of children at younger ages due to disagreement on the appropriate classification of excess and unhealthy weight in early childhood (Gwozdz et al., 2013). In my study weight is classified according to several alternative measures shown to be more valid and reliable than a standard measure of raw BMI, which allows me to examine multiple objective measures of excess weight in young children (Vidmar et al., 2013).

Finally, I contribute to the growing literature investigating the mechanisms of effect between economic deprivation and child weight, by describing the association between parental employment change and children's diet and physical activity. Of those studies which investigate the association between unemployment and child weight, few examine the potential channels of effect (Costa-Font & Gil, 2013).

I exploit 3 waves (2008, 2011, 2013) of the Growing up in Ireland Infant Cohort Study (n = 11,134). Logistic fixed effects regression is used to estimate the relationship between excess child weight (BMI, weight for age, weight for height > 2 standard deviations), a healthy weight (BMI, weight for age, weight for height > -2 standard deviations and < 2 standard deviations) and a binary measure of parental unemployment adjusted for family socio-demographic characteristics, urban or rural location and year fixed effects.

Analysing anthropometric data in children has historically been complex compared to adults, who have a standard cut off score (Lobstein et al., 2004). However, population-based reference data are now available, and can be used to transform raw anthropometric data to standard deviation scores which are then standardised to a reference population for the child's age/height/length and gender (Wright et al., 2010). Thus weight-for-age, weight-for-height, height for age and BMI for age can be used to answer the question of whether a child is healthy when measured on these scales compared to other children of the same age and sex (Jones et al., 2017).

I find that early life exposure to parental unemployment has a detrimental effect on children's health. Either parent experiencing unemployment is associated with an increase in the probability of a child being overweight by 6 percentage points according to BMI for age. For weight for age the probability is 5, 6 and 5 percentage points higher across the World Health Organisation (WHO), British Growth Reference, and Centers for Disease Control (CDC) growth charts. The probability of a child being a healthy weight for age is 4 percentage points lower according to the CDC growth charts and 5 percentage points according to the British Growth Reference growth charts. As a continuous measure, either parent experiencing unemployment is associated with an increase in the child's weight by 0.04 standard deviations for BMI, 0.04 standard deviations for weight for height, and 0.03 standard deviations for weight for age across the different growth charts.

Replicating the analysis according to which parent is unemployed, I find a stronger paternal effect, which may imply an income effect. However, this effect is ambiguous as in the data mothers assume the traditional role of caregiver and thus experience little employment change (Williams, 2013). The results are contrary to the literature on aggregate unemployment and child weight cross-sectionally which finds mixed results but are consistent with research on aggregate unemployment and adiposity in children in panel studies.

Identifying mechanisms of effect is empirically challenging in this study as information on diet and physical activity are not available in each wave. I replicate the core analysis of parental unemployment and child weight, substituting anthropometric outcomes for the quality of diet, and physical activity with and without an implied cost. I exploit the longitudinal nature of the employment data to create an indicator for parents who become unemployed in the wave in which children's health behaviours are measured. Results indicate that the probability of a child consuming healthy food and physical activity with an implied cost is lower if either parent experiences unemployment, while the probability of consuming unhealthy food is higher.

The probability of a child consuming vegetables is lower if the family has experienced unemployment; likewise, there is a higher probability of consuming unhealthy foods such as french fries, crisps and processed snacks. Similarly, the probability of a child doing a paid-for leisure activity is lower in children where either parent has experienced unemployment. Physical activity without an associated cost is either insignificant or of a decreased magnitude of significance when compared to costly activities. My findings align with the literature on the importance of economic downturns for the nutritional composition of children's diet and the frequency of exercise (Bellés-Obrero et al., 2016).

These estimates are consistent with the hypothesis of an income effect; however, the analysis on diet and physical activity relies on cross-sectional outcome data, and thus should be interpreted as correlational rather than causal. These results suggest that excess weight prevention efforts could target the children of unemployed parents and that unemployment may influence child weight through declines in physical activity and diet which require a financial investment.

As robustness tests, I repeat the analysis adjusting children’s age for term of birth, applying supplementary “placebo” regressions, extending the identification strategy and finally reweighting the data to be representative of children who have left the sample. Results are qualitatively the same in magnitude and direction of effect across these tests. The remainder of the paper is organised as follows: Section 2 discusses related literature, Section 3 describes the data, Section 4 sets out the methodology, Sections 5 and 6 present results and robustness tests respectively, Section 7 provides a discussion of results and Section 8 concludes.

2. The Irish Recession and Child Weight.

Excess weight in infants and young children is a significant health problem facing many industrialised countries, particularly in Ireland, where it is described as a public health crisis, with 1 in 5 boys and over 1 in 4 girls defined as overweight or obese (Perry et al., 2017). The incidence of childhood obesity is such that the Government's Special Rapporteur on Children has termed childhood obesity 'a vital child protection issue and a challenge to implementation of the right of children to the highest attainable standard of health in Ireland' (P. 48 Shannon, G. (2014) Seventh Report of the Special Rapporteur on Child Protection).

Overweight in children is an important public policy issue as significant adverse effects are associated with excess weight in the early stages of life. Deteriorations in health may have on-going effects, and the cumulative impact on health services usage is expected to be substantial (Shannon, 2014). Excess weight in childhood also negatively affects school performance, social inclusion and long-run labour market outcomes and earnings (Bellés-Obrero et al., 2016; Cawley, 2004; Gortmaker et al., 1993).

Excess weight in childhood also strongly predicts adult overweight and obesity, increasing the probability of children experiencing chronic disease in later life. Research finds that 55% of obese children continue to be obese into adolescence, and 80% of obese adolescents remain obese into adulthood (Simmonds et al., 2015, 2016). The intergenerational nature of the rise in childhood adiposity is an indicator of future rises in chronic diseases as it increases the probability of cardiovascular diseases, type 2 diabetes, cancer and other chronic diseases in adulthood (Müller-Riemenschneider et al., 2008).

From a theoretical perspective, it is difficult to predict the impact of an economic downturn on children’s weight. The literature identifies three core mechanisms through which unemployment is assumed to act on weight, but the direction of the effect for weight gain or weight loss is often ambiguous.

Parental unemployment decreases the opportunity cost of time, which may encourage or maintain a healthy weight in children. Particularly, unemployment may increase the amount of time available to parents to engage in time-intensive health-promoting behaviours, such as the preparation of home-cooked meals (Cawley & Liu, 2012; Liu et al., 2009). Likewise, parents may have more time to take children out for physical activity (Anderson et al., 2003; Ziol-Guest et al., 2013). Conversely, unemployed parents may choose to spend this increased free time on sedentary behaviours, such as watching television (Colman & Dave, 2013).

Unemployment also has an income effect, which may lead to excessive weight gain in children. Parental unemployment reduces family income which may result in children eating larger amounts of inexpensive, energy-dense high-caloric food of poor nutritional value (Bellés-Obrero et al., 2016; Dave & Kelly, 2012; Griffith et al., 2013). Parents may also be less able to afford children's physical activities which are costly to attend, either due to travel, membership fees, or equipment costs (Jo, 2018).

Unemployment increases psychological stress in households, creating an obesogenic home environment for children (Gundersen et al., 2011). Unemployment is associated with declines in mental health and an increase in rates of suicide (Ruhm, 2015). As parents experience unemployment, they also experience psychological strain. Early childhood exposure to parental psychological distress can deregulate the stress response system, affecting pathways which regulate body composition and metabolic function, leading to weight gain (Nobari et al., 2018).

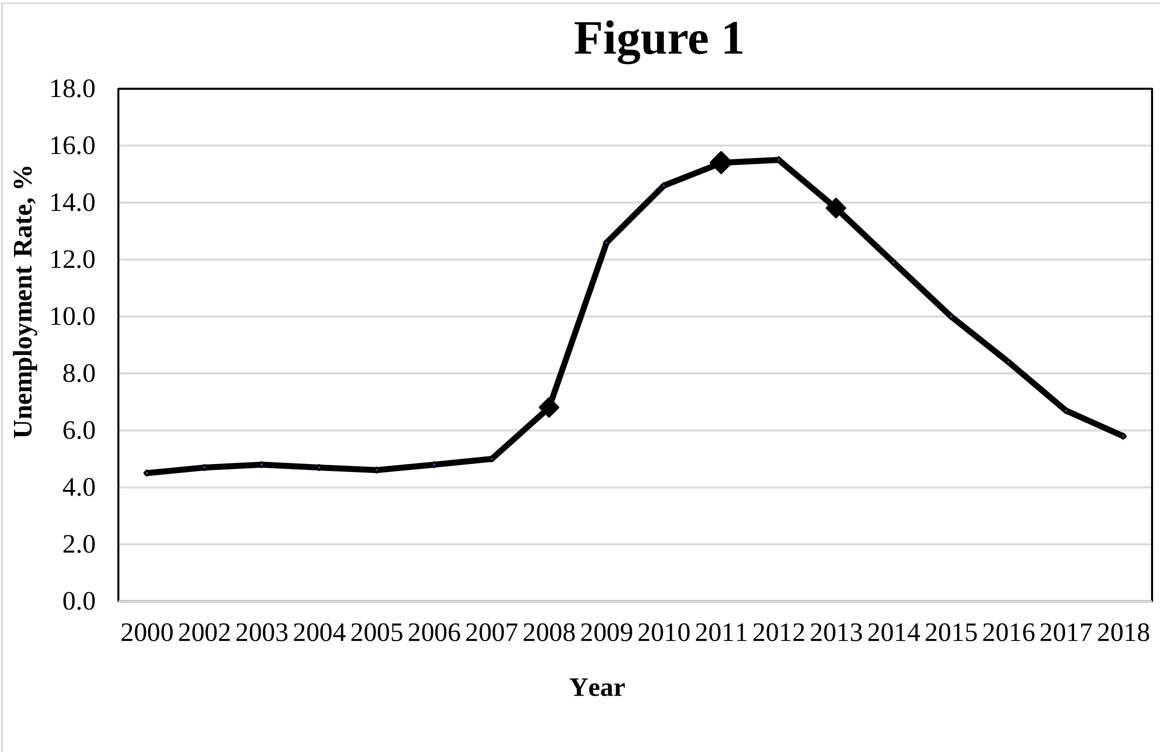
Analysis of the impact of unemployment on weight is largely limited to adults. Current studies on unemployment and child weight predominantly focus on birth weight and produce conflicting results. Dehejia and Lleras-Muney (2004) find that babies conceived during times of increased national unemployment have a higher incidence of healthier birth weight. Aparicio Fenoll and Gonzalez (2014) report similar results. On the contrary, Bozzoli and Quintana-Domeque (2013) and van den Berg and Modin (2013) find either contradictory or no significant effects on birth weight.

The handful of studies that examine the relationship between parental unemployment and young children's weight rely on repeated cross-sectional data. These studies, conducted in Europe for a similar period as mine, report that parental unemployment leads to decreases in child weight, increases in child weight, and no effect on child weight, respectively (Bellés-Obrero et al., 2016; Gwozdz et al., 2013; Rajmil et al., 2013). These contradictory results may reflect the difficultly in deriving causal estimates from cross-sectional analysis. Thus, the Growing Up in Ireland study provides the opportunity to use panel data to measure the influence of parental unemployment on weight at 9 months, 3 years and 5 years old.

The closest longitudinal study to this paper is Oddo et al. (2016) which uses anthropometric measurements in a panel dataset to examine children's risk of overweight/obesity in the State of California. They find a 1-percentage point (pp) increase in unemployment is associated with a 1.4 pp increase in the risk of overweight/obesity in children. However, the data is based on older children (7–18 years), only includes one anthropometric measure, and does not include individual-level parental employment status; instead, county-level annual unemployment estimates were obtained from the Bureau of Labor Statistics. In my study parental employment status is recorded directly and multiple objective anthropometric measures are available at each wave.

Much of the previous literature employs a single anthropometric measure, usually BMI as created by weight in kilograms divided by height in metres squared (Gwozdz et al., 2013). However, weight for age and weight for height are also useful indicators (Aris et al., 2018; Lobstein et al., 2004). Each measure has advantages, and which is optimum is ambiguous. I improve on previous studies by examining several different measures for adiposity built from objectively measured height and weight; this provides a more valid and reliable measure of excess weight, increasing the comparability of results to a variety of studies.

Analysis of parental unemployment and child health also often suffers from a lack of variation in parental employment, particularly in those studies which precede the Great Recession (Bellés-Obrero et al., 2016; Gwozdz et al., 2013; Rajmil et al., 2013). Thus, many studies consider aggregate unemployment effects, rather than individual-level parental employment change (Byron & Fertig, 2012). The Growing up in Ireland data are collected before (2008), during (2011) and after (2013) the Irish recession, as per Figure 1. This timing provides an economic shock which significantly increased the variation in the numbers unemployed, providing an opportunity to test the consequences of parental unemployment on child weight. Likewise, few studies address what has been described as the two main drivers of weight gain, diet and physical activity (Gwozdz et al., 2013). The Growing Up in Ireland study collects data on children's diet in 2011 and 2013 and physical activity in 2013.



- Figure 1. Percentage unemployed Ireland, 2000–2018. Squares denote waves 1, 2, and 3 of the Growing Up in Ireland Infant Cohort Study. Data were obtained from Eurostat in 2019 (Eurostat, 2019) .

Byron and Fertig (2012) also analyse infant weight in panel data in the U.S. but are similarly limited by a lack of individual level data on parental employment, relying on state-level unemployment rates instead. They find that increases in local unemployment are associated with a lower percentile body mass index (BMI) for children, but only in households with debt. The limited knowledge base on employment and child weight is reflected in these sole longitudinal studies of this relationship, as panel data studies have not been published outside the Byron and Fertig (2012) or the Oddo et al. (2016) studies in the U.S. context, or at all for individual-level parental unemployment effects on child weight.

3. **The Data.**

I use three waves of the Growing Up in Ireland Infant Cohort Study (GUI). GUI is a nationwide study that takes a nationally representative sample of 11,134 Irish children born between December 2007 and June 2008 in the Republic of Ireland and follows them longitudinally for the years of the study (Thornton et al., 2013). The infant cohort was randomly selected from Ireland's Child Benefit Register and represents ~15% of all births in Ireland in 2008. The unit of observation is the family/household. The first wave of data was collected in 2008, when the infants were 9 months old. The second wave of data was collected in 2011 at three years old, and the third wave was collected in 2013 at five years old. Thus, data was collected before, during and after the recession. I limit the sample to children with at least two measurements on weight, 90% of the sample, in order to provide within-child estimates. The final estimation sample includes 10,011 children.[1]

3.1. **Outcomes measures.**

Weight in adults is predominantly measured by BMI, and universal cut-offs differentiate adults who can be considered a healthy weight, overweight, or obese. However, for children, a universal measure of excess weight does not exist, as it depends on the age and gender of the child. BMI varies with child age and gender, naturally increasing in the first months after birth, falling after the first year and rising again after the sixth year in an 'adiposity rebound' and thus it must be evaluated against age- and gender-specific reference values (Lobstein et al., 2004).

Difficulties in defining reliable thresholds in early childhood have historically limited studies on this topic (De Onis, 2015). A standardised definition of excess weight is necessary to predict health risks and provide comparisons between populations and until recently, no such standard definition existed (Roy et al., 2015; Vidmar et al., 2013). Unlike BMI, which was introduced in the early seventies, the WHO Child Growth Standards were established relatively recently, in 2006 (Blackburn & Jacobs, 2014). These are reference standards based on the age and gender of the child. The standards are constructed for zero to five-year-olds from ~27,000 anthropometric measures in children internationally (Dinsdale et al., 2011). Sex- and age-specific thresholds are based on standard deviations from the mean height, weight or BMI per age and gender or height

[1]In the extensions to this analysis on page 29 I illustrate that my findings are robust to possible attrition bias from the 10% of children without multiple weight measures.

and gender. Across indices, children are classified as overweight if their anthropometric measure is 2 standard deviations from the reference mean (Grummer-Strawn et al., 2009; Wright et al., 2010).

Levels of overweight in the GUI have previously been reported using measures created by the International Obesity Task Force (IOTF). The IOTF child cut-offs for overweight are based on and linked to the corresponding adult BMI cut-offs. It is not possible to categorise child weight before the age of 2 years using these cut-offs (Cole & Lobstein, 2012). There are also concerns for the predictive power of the IOTF cut-offs for later weight gain and morbidity, and to suggest that this measure may not be universally applicable across child populations (Forouhi et al., 2019; Lobstein et al., 2004)[2].

On the other hand, the WHO child BMI measure is significantly associated with relative adiposity in young children. It has a high true positive rate and a low false positive rate for predicting a high percentage of total body fat in children. While this measure may classify some overweight children as normal weight, few healthy children will be falsely classified as overweight (Lobstein et al., 2004). The WHO infant BMI is also strongly associated with Health-related quality of life (HRQoL), adult body composition and cardiometabolic risk later in childhood, linear growth and pubertal development (Aris et al., 2017, 2019; Bolton et al., 2014; Roy et al., 2015; Slining et al., 2013; Sovio et al., 2014).

However, BMI may be an insensitive measure of adiposity for children who are very tall, very short or have other unusual body fat distributions. In these situations, weight-for-height takes account of possible confounding from linear growth and is a suitable alternative means of assessing child weight before the age of 6 (Lobstein et al., 2004). In addition, having a high weight for height predicts poor cardiometabolic outcomes and obesity during early adolescence (Aris et al., 2018).

The CDC recognises the WHO growth standard as the preferred reference for child weight before the age of 2 (Grummer-Strawn et al., 2009). However, to confirm that the results of the analysis are not an artefact of the reference chart used, I also compare weight for age from the WHO standard with two additional sets of population-based reference data: the British Growth Reference

[2]This may help to explain the higher prevalence of excess weight reported by the GUI study (McCroy, Murray, Williams, & McNally, 2013).

growth charts and the CDC growth charts. Note that these standards constitute the conventional alternatives to the WHO standard and that weight for age is the only outcome available across all three growth charts (Vidmar et al., 2013).

I transform raw child anthropometric data[3] to age- and sex-specific standard deviation z-scores using the *zanthro* package for Stata developed by Vidmar et al. (2013). I consider a continuous distribution of weight in the analysis and indices of relative adiposity in children created from the above growth reference charts based on the difference between the observed value and mean reference value of the population for children before the age of six. These growth charts also provide a healthy weight range. Children who are in the normal weight range for their gender and age/height, i.e. not overweight or underweight, are described as being a healthy weight, children outside this range, are not.[4] I describe the healthy weight and overweight thresholds, and the studies that inform them, in Table A1 in the appendix.

3.2 **Control variables**

I include maternal age, education, marital status and indicators for year and urban or rural location as control variables, as evidence suggests that unemployment may have a larger effect on child health for the children of younger, unmarried or lower educated mothers (Anderson et al., 2003; Cawley & Liu, 2012; Gwozdz et al., 2013; Liu et al., 2009). Oddo et al. (2016) similarly control for region by urban or rural location when considering the impact of unemployment on children's weight. As informed by previous studies of unemployment on child health by Bozzoli and Quintana-Domeque (2013), Liu et al. (2009), Oddo et al. (2016) and Rajmil et al. (2013) I do not control for paternal characteristics, as this removes single mothers from the analysis who are expected to be particularly economically vulnerable. Studies on coupling behaviours indicate that husbands generally hold similar socioeconomic characteristics to their partners (Qian, 2017). According to Scholder (2008) any changes in parental employment which may influence children's weight (through changes in income, the opportunity cost of time, et cetera) will also influence

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[3]Trained interviewers measured weight and length/height of the study child at each wave using the SECA 835 portable electronic scales, the SECA 210 measuring mat for wave 1 and a Leicester measuring stick for waves 2 and 3.

[4]For the CDC measures of healthy weight and overweight I establish the position of the child on the reference percentile distribution relative to the measure provided by the CDC for a healthy weight child and an overweight child.

parental weight, and thus parental weight should not be included in the analysis. Consequently, I do not include parents' weight in my study similar to this, and other studies of unemployment and child weight (e.g. Bellés-Obrero et al., 2016; Costa-Font & Gil, 2013; Nobari et al., 2018; Oddo et al., 2016; Rajmil et al., 2013). Finally, when I create the weight outcomes using the *zanthro* package, I adjust these for the age and the sex of the child.

3.3 **Treatment variable**

The primary predictor is parental unemployment. The definition of unemployment is an individual who is jobless and actively seeking work (Mincy & De la Cruz Toledo, 2014). Hence, I create a binary variable for unemployment where I consider parents to be unemployed, only if they, or their partner on their behalf, report that they are unemployed and actively looking for a job according to the GUI data.[5] Parents who are in education, on a state training scheme, home duties, long term sickness or retired are not considered unemployed. Descriptive statistics on all these variables are reported in Table 1 and shows little variation in maternal unemployment over time, yet considerable increases in paternal unemployment, which follow the national trend.

Table 1:
Descriptive Statistics

	Wave 1	Wave 2	Wave 3
BMI (WHO)	2008	2011	2013
BMI Z-Score	0.74	0.92	0.59
Healthy Weight	58.33%	53.37%	67.01%
Overweight	11.34%	13.86%	7.97%
Weight for Height (WHO)			
Z-Score	0.87	1.07	0.48
Healthy Weight	86.01%	83.05%	92.54%
Overweight	13.31%	16.58%	6.54%
Weight for Age (WHO)			
Z-Score	0.98	0.74	0.62
Healthy Weight	85.06%	90.43%	91.77%

[5]Partner reports are a common source of information in studies of economic change and child weight (Cawley & Liu, 2012; Jo, 2018; Mincy & De la Cruz Toledo, 2014; Ziol-Guest et al., 2013).

Overweight	14.49%	9.38%	7.87%
Weight for Age (CDC)			
Z-Score*	0.68	0.74	0.61
Healthy Weight	82.10%	80.77%	86.50%
Overweight	16.65%	17.74%	12.08%
Weight for Age (UK)			
Z-Score	0.71	0.60	0.58
Healthy Weight	87.50%	90.20%	91.38%
Overweight	11.63%	8.82%	7.87%
Independent Variables			
Either Parent Unemployed	11.19%	18.08%	14.57%
Father Unemployed	9.40%	16.58%	13.15%
Mother Unemployed	3.56%	4.76%	4.15%
Maternal Economic Status			
Employee	52.94%	51.12%	52.01%
Self-employed	4.65%	5.10%	6.09%
Student	1.51%	1.82%	1.46%
Long-term sickness	0.65%	1.14%	1.28%
Home duties	35.43%	34.47%	33.17%
Paternal Economic Status			
Employee	66.62%	59.38%	61.28%
Self-employed	21.93%	21.86%	22.82%
Student	0.84%	1.03%	1.06%
Long-term sickness	1.05%	1.37%	1.49%
Home duties	0.16%	0.22%	0.20%
Mother’s Marital Status			
Married – Living with partner	69.47%	73.08%	75.95%

Married – Seperated from partner	1.77%	2.39%	2.80%
Divorced/Widowed	1.21%	1.47%	1.32%
Never Married	27.56%	23.02%	19.82%
Mother's Education			
Primary school or lower	2.28%	1.33%	1.09%
Secondary schooling	27.55%	21.38%	17.34%
Non-degree further education	33.25%	36.74%	42.14%
Primary degree or equivalent	23.16%	23.33%	22.08%
Postgraduate education	13.71%	17.11%	17.34%
Child Age (Months)	9	36	60
Mother's Age (Years)	28	30	32
Urban Location	43.59%	43.03%	39.88%
Rural Location	56.41%	56.97%	60.12%

*The estimation sample (N) comprises those 10,011 children with at least two measurements on weight.*CDC percentiles are converted to z-scores to maintain equivalence across measures. Weight categories that do not sum to 100% reflect small numbers of underweight children, or that the WHO BMI measure of healthy weight does not include children at risk of overweight.*

4. Econometric specification

I use a fixed-effects panel logistic model with child and time fixed effects, controlling for urban or rural location, to examine the association between parental unemployment and the binary measure of healthy weight or overweight, as below:

$$logit[P(Y_{it} = 1)] = \beta_0 + \beta_1 UR_{it} + \beta_2 X_{it} + \alpha_i + \delta_l + \gamma_t + \varepsilon_{it}$$

Where Y_{it} represents the two measures of child healthy weight or overweight (by BMI, weight-for-height or weight-for-age) for the *i*-th child. In either case the binary response outcome takes the value of "1" if the child is overweight or a healthy weight and "0" if the child is not. β_0 is the intercept, the other β's are the effects of the predictors (logit coefficients transformed to marginal effects) UR_{it} is the unemployment status of the mother, father or either parent in time t, thus β1 is the coefficient of interest, the effect of parental unemployment on weight. X_{it} is a vector of maternal characteristics (mother's age, education and marital status), δ_l controls for location (urban or rural), γ_t is the time fixed effect, and ε_{it} is the error term, clustered at the individual level and assumed to be distributed independently across observations, and to δ_l and γ_t (Mincy & De la Cruz Toledo, 2014). Through maximum likelihood, my model describes the probability that Y_{it} will take on the value of "1" for overweight or healthy weight in children (Mincy & De la Cruz Toledo, 2014). For the continuous z-scores, I replicate the above with a linear rather than a logistic regression.

Independence is assumed across, but not within, individuals in panel data. In the model α_i is an individual-specific parameter representing the effect of unobserved individual characteristics, the individual specific fixed-effect. Including this removes the bias from time-invariant omitted variables, regardless of observability (Byron & Fertig, 2012). The fixed effects model controls for characteristics that may influence children's weight that are associated with location, year, maternal and child characteristics. This strategy allows me to compare the same child over time, thus controlling for all measured and unmeasured time-invariant individual characteristics, which may influence their reaction to parental employment change (e.g. dietary preference, athletic interests, et cetera) (Oddo et al., 2016). Similarly, the recession provides considerable employment variation, and thus, this identification strategy allows me to test whether changing economic conditions influence the probability of adiposity in the early years of childhood.

5. Results

The estimates in Table 2 indicate that either parent being unemployed is associated with an increase in the probability that a child is overweight. Column 1 shows that for weight measured by BMI, either parent experiencing unemployment is associated with an increase in the child's weight of 0.04 standard deviations. Likewise, the probability of a child being overweight is 6 percentage points higher if either parent has experienced unemployment. These results are qualitatively the same for the z-score for weight for height (0.04 standard deviations), although the probability of overweight is no longer significant. For weight for age, either parent experiencing unemployment is associated with an increase in the child's weight of 0.03 standard deviations across all three charts. Likewise, the probability of a child being overweight is 5, 6 and 5 percentage points higher using the World Health Organisation (WHO), British Growth Reference, and Centers for Disease Control (CDC) growth charts. The probability of having a healthy weight for age is negative across all three charts. The probability of a child having a healthy weight is 4 percentage points lower according to the CDC growth charts and 5 percentage points lower according to the British Growth Reference growth charts if either parent has experienced unemployment.

The continuous z-score increases in weight may appear modest. However, if this expansion in weight occurs at the margins, i.e. for children at the upper ends of the weight distributions, this will result in clinically significant increases in weight as children cross the threshold from healthy weight to overweight (World Health Organization, 2000). In sum, the estimates across the different reference charts indicate that the results are not an artefact of the chosen reference chart.

Columns 2 and 3 of Table 2 compares the effects depending on whether the father or mother experienced unemployment. The results indicate a significant association between paternal unemployment and the probability of excess or unhealthy weight in children, however no such association is found for maternal unemployment, except for weight for height.

Table 2:
Parental Unemployment and Child Weight

	Either Parent Unemployed	Father Unemployed	Mother Unemployed
BMI (WHO)			
Z-score	0.04*	0.03	0.05
	(0.02)	(0.03)	(0.03)
Healthy Weight	0.01	-0.01	0.03
	(0.02)	(0.02)	(0.03)
Overweight	0.06**	0.06*	0.04
	(0.02)	(0.03)	(0.04)

Weight for height (WHO)			
Z-score	0.04*	0.03	0.05†
	(0.02)	(0.02)	(0.03)
Healthy Weight	-0.02	-0.04	0.02
	(0.02)	(0.03)	(0.04)
Overweight	0.03	0.03	0.00
	(0.02)	(0.03)	(0.04)
Weight for age (WHO)			
Z-score	0.03*	0.02	0.03
	(0.01)	(0.02)	(0.02)
Healthy Weight	-0.04	-0.06†	0.02
	(0.03)	(0.03)	(0.04)
Overweight	0.05*	0.06†	-0.01
	(0.02)	(0.03)	(0.04)
Weight for age (CDC)			
Z-score	0.03*	0.02	0.03
	(0.01)	(0.02)	(0.02)
Healthy Weight	-0.04†	-0.04	-0.01
	(0.02)	(0.03)	(0.04)
Overweight	0.05*	0.03	0.03
	(0.02)	(0.03)	(0.04)
Weight for age (UK)			
Z-score	0.03*	0.02	0.03
	(0.02)	(0.02)	(0.02)
Healthy Weight	-0.05†	-0.07*	0.03
	(0.03)	(0.03)	(0.04)
Overweight	0.06*	0.07*	0.01
	(0.03)	(0.03)	(0.05)

*Note: Coefficients are from unique linear and logit fixed effects models. The estimation sample (N) comprises those 10,011 children with at least two measurements on weight. Control variables are included for maternal age, education, marital status, year and location (urban or rural). Standard errors are clustered to allow for correlation within individuals. The number of observations varies by the weight measure considered. Standard errors are reported. † p< .10, * p<0.05, ** p<0.01, and *** p<0.001. CDC percentiles are converted to z-scores to maintain equivalence across measures.*

5.1 Parental unemployment and channels of effect explored.

Bellés-Obrero et al. (2016) suggest that diet and physical activity are the most significant determinants of an unhealthy weight in the early years of childhood. Trading down is a common strategy in families that face economic shocks, who lower the quality of food purchased to reduce cost (Lobstein et al., 2004). Research shows that income constrained families have a greater likelihood of choosing diets with high contents of added sugars, fats and refined grains to meet daily calorie requirements (Loughnane & Murphy, 2015). Similarly, with limited resources, families may no longer be able to afford travel, equipment or membership costs for children's leisure-time physical activities (Jo, 2018). As unemployment constitutes a significant, negative, income shock, the findings above may be consistent with an effect of income declines on diet and physical activity. An income effect may thus explain the mechanism underlying the relationship between parental unemployment and child weight, and in particular the greater impact of paternal unemployment for child weight as fathers are traditionally the primary earner in the data (Thornton et al., 2013). If unemployment changes the opportunity cost of time, I would expect the probability of physical activity to increase and the probability of consuming “ready meals” to decrease (Anderson et al., 2003).

To investigate this, I replicate the analysis in Table 2 using the same econometric specification as before but replace the measures of weight with measures of diet and physical activity. Information on diet and physical activity in children was not recorded longitudinally in the GUI data. In wave 2 (2011) dietary frequency was measured in the last twenty-four hours, while in wave 3 (2013) dietary frequency was measured in the last 30 days. This necessitated the use of binary consumption outcomes to maintain comparability across measures. Equivalently, children’s physical activity was only recorded in 2013. To mitigate the limitations of the cross-sectional measures, in Table 3 I exploit the longitudinal nature of the measures of parental employment to create an unemployment variable that is true for parents who were employed previously and became unemployed in the wave where the child's health behaviour is studied. This allows me to investigate the influence of a change from parental employment in previous waves to parental unemployment in the present wave, on children's health behaviours in this wave.

Table 3 shows that the probability of a child consuming healthy food and physical activity involving an implied cost is lower if either parent experiences unemployment, while the probability of consuming unhealthy food is higher. According to the results, the probability of a child consuming vegetables is 1 percentage points lower in 2011 if the family has experienced unemployment than if it has not. The probability of consuming french fries and crisps are 5 percentage points higher in children where either parent has experienced unemployment. Likewise, the probability of consuming prepared food (burgers/pies/sausage rolls) and sweets are 4 and 2 percentage points higher. An additional 80.20 daily calories are consumed by children who experience unemployment of either parent in 2013. The probability of consuming vegetables is 3 percentage points lower, while the probability of consuming french fries, crisps, prepared food (pizza/sausages/hotdogs) and sweet desserts are 2, 1, 1 and 2 percentage points higher in 2013 for children where either parent has experienced unemployment. The probability of a child doing a paid-for leisure activity is 7 percentage points lower for children where either parent has experienced unemployment. Likewise, sports club membership, using a bicycle/tricyle/scooter or swimming are 5, 1 and 9 percentage points lower. Physical activity without an associated cost is either insignificant or of a decreased magnitude of significance when compared to costly physical activities. These estimates are consistent with the hypothesis of an income effect.

Nonetheless, this analysis relies on cross-sectional outcome data and the relationship between parental unemployment and child health behaviours may be attributed to some unobservable characteristics associated with the family or the child. Results should thus be interpreted as suggestive rather than causative (Gwozdz et al., 2013).

Table 3:
Parental Unemployment, Diet and Physical Activity

Diet in 2011	Either Parent Unemployed	Father Unemployed	Mother Unemployed
Vegetables	-0.01*	-0.02**	-0.01
	(0.01)	(0.01)	(0.01)
French Fries	0.05***	0.06***	-0.00
	(0.01)	(0.01)	(0.01)
Crisps	0.05***	0.06***	-0.02
	(0.01)	(0.01)	(0.01)
Burgers/Pies/Sausage Rolls	0.04***	0.05***	0.01
	(0.01)	(0.01)	(0.01)

Sweets	0.02*	0.00	0.03†
	(0.01)	(0.01)	(0.02)
Diet in 2013	Either Parent Unemployed	Father Unemployed	Mother Unemployed
Daily Calories	80.20***	91.80***	101.59***
	(9.97)	(11.22)	(15.96)
Vegetables	-0.03**	-0.04***	-0.03**
	(0.01)	(0.01)	(0.01)
French Fries	0.02***	0.02**	0.03***
	(0.00)	(0.01)	(0.01)
Crisps	0.01†	0.00	0.01
	(0.00)	(0.01)	(0.01)
Pizza/Sauasages/Hotdogs	0.01*	0.00	0.01†
	(0.00)	(0.00)	(0.01)
Sweet Desserts	0.02*	0.03*	0.00
	(0.01)	(0.01)	(0.02)
Physical Activity in 2013	Either Parent Unemployed	Father Unemployed	Mother Unemployed
Physical Activity Requiring a financial investment			
Does the child do a paid for leisure activity?	-0.07***	-0.06***	-0.09***
	(0.01)	(0.01)	(0.01)
Sports Club Membership	-0.05***	-0.08***	-0.04*
	(0.01)	(0.01)	(0.02)
Uses a bicycle tricycle or scooter	-0.01*	-0.01*	0.00
	(0.00)	(0.00)	(0.00)
Swimming	-0.09***	-0.10***	-0.07***
	(0.01)	(0.01)	(0.02)
Physical Activity Not requiring a financial investment			
Climbing	-0.01*	-0.02*	-0.01
	(0.01)	(0.01)	(0.01)
Playing with a ball	0.00	0.00	0.01*
	(0.00)	(0.00)	(0.00)
Chasing	-0.00†	-0.01*	-0.00
	(0.00)	(0.00)	(0.00)

*Note: Coefficients are from unique linear and logit fixed effects models. The estimation sample (N) comprises those 10,011 children with at least two measurements on weight. Control variables are included for maternal age, education, marital status, year and location (urban or rural). Standard errors are clustered to allow for correlation within individuals. The number of observations varies by the outcome measure considered. Standard errors are reported. † p< .10, * p<0.05, ** p<0.01, and *** p<0.001.*

6. Robustness checks and extensions.

6.1 Falsification test.

To support the credibility of the identification strategy, I perform additional supplementary "placebo" regressions, as informed by Costa-Ramón et al. (2018). In developed countries, such as Ireland, a child's stature is almost entirely predetermined, even before conception, by genetics (McEvoy & Visscher, 2009). Thus, unlike weight, height is not expected to fluctuate with abrupt changes in parental unemployment. Equally, in developed nations clinically significant outcomes, like stunting, are insensitive to short-term economic changes in parental unemployment (Bann et al., 2018; Stewart et al., 2013). Consequently, children's height provides an outcome that is unrelated to changes in parental employment.

Height-for-age describes linear growth and is available across each child growth chart used in this study. The core analysis in Table 2 is thus repeated for the WHO, CDC and British Growth Reference growth charts. Children's height is created as continuous (z-score), and binary measures (stunting, or height-for-age < - 2 SDs below reference mean). The results of this analysis, in Table 4, provides little evidence to support an effect of parental unemployment on children's height. Thus, qualitatively different conclusions are reached using the placebo, demonstrating that the unemployment effect does not exist when it "should not". This provides evidence in favour of the chosen specification (Auld & Grootendorst, 2004; Mills & Patterson, 2009).

Table 4:
Parental Unemployment and Child Height

	Either Parent Unemployed	Father Unemployed	Mother Unemployed
Height (WHO)			

Z-score	0.01	0.01	-0.01
	(0.02)	(0.02)	(0.03)
Stunting	-0.02	0.00	0.13
	(0.04)	(0.02)	(0.10)
Height (CDC)			
Z-score	0.01	0.00	-0.00
	(0.02)	(0.02)	(0.02)
Stunting	-0.04	-0.03	0.03
	(0.05)	(0.04)	(0.09)
Height (UK)			
Z-score	0.01	0.01	-0.01
	(0.02)	(0.02)	(0.03)
Stunting	-0.02	0.00	0.09
	(0.04)	(0.02)	(0.10)

*Note: Coefficients are from unique linear and logit fixed effects models. The estimation sample (N) comprises those 10,011 children with at least two measurements on weight. Control variables are included for maternal age, education, marital status, year and location (urban or rural). Standard errors are clustered to allow for correlation within individuals. The number of observations varies by the height standard considered. Standard errors are reported. † p< .10, * p<0.05, ** p<0.01, and *** p<0.001. CDC percentiles are converted to z-scores to maintain equivalence across measures.*

6.2 Investigating the influence of secular trends.

There have been significant increases in the rates of childhood overweight and obesity internationally (Lobstein et al., 2004). Although weight was assessed by deviation from child growth charts, to further control for the possibility that international trends in children's weight are driving the effects seen in Table 2, I replace the coefficient of interest, parental unemployment, with a new variable created from pure noise.[6] If its effect is significant, this may indicate that I am observing a secular increase in child weight, and incorrectly attributing this to an association with parental unemployment (Abadie et al., 2007; Bertrand et al., 2004; Colman & Dave, 2013; Galiani et al., 2005; Mills & Patterson, 2009). I use the *runiform()* function in Stata to produce a random

[6]This is as informed by Bertrand et al. (2004) and Bound et al. (1995) who similarly apply randomly generated placebo treatments in employment data.

number for each parent for each year.[7] I create a binary variable, such that when this random number is below 0.5, the binary variable is true; and when this random number is above 0.5, the binary variable is false. Thus, parents are randomly assigned a true or false binary variable at each year (Buis, 2007). As the random number changes across waves, this binary variable will change or remain constant. I repeat the analysis for Table 2, substituting this random binary variable for the actual parental unemployment variable. The results of this analysis, reported in Table 5, do not indicate an impact on any child weight outcomes. Bozzoli and Quintana-Domeque (2013), Jo (2018) and Scholder (2008) similarly analyse the importance of placebo treatments when studying the relationship between employment and child weight, and suggest that a lack of effect decreases the likelihood that the relationship identified is spurious.

Table 5:
Placebo Treatment and Child Weight
(Investigating the influence of secular trends)

	Either Parent Unemployed	**Father Unemployed**	**Mother Unemployed**
BMI (WHO)			
Z-score	-0.01	0.01	-0.01
	(0.01)	(0.01)	(0.01)
Healthy Weight	0.01	0.00	0.01
	(0.01)	(0.01)	(0.01)
Overweight	-0.02	-0.02	-0.01
	(0.01)	(0.02)	(0.01)
Weight for height (WHO)			
Z-score	0.01	0.01	-0.02
	(0.01)	(0.01)	(0.01)
Healthy Weight	-0.01	0.02	0.00
	(0.01)	(0.01)	(0.01)
Overweight	0.01	-0.02	-0.00
	(0.01)	(0.01)	(0.01)

[7] The Mersenne Twister random number generator is used. This is a recursive formula, such that the numbers are random but deterministic, making results reproducible (Matsumoto & Nishimura, 1998).

Weight for age (WHO)			
Z-score	-0.01	0.01	-0.00
	(0.01)	(0.01)	(0.01)
Healthy Weight	-0.01	0.02	0.00
	(0.01)	(0.02)	(0.01)
Overweight	0.01	-0.02	0.00
	(0.01)	(0.02)	(0.02)
Weight for age (CDC)			
Z-score	-0.01	0.01	-0.00
	(0.01)	(0.01)	(0.01)
Healthy Weight	0.00	0.01	-0.01
	(0.01)	(0.01)	(0.01)
Overweight	0.00	-0.01	0.01
	(0.01)	(0.01)	(0.01)
Weight for age (UK)			
Z-score	-0.01	0.01	-0.00
	(0.01)	(0.01)	(0.01)
Healthy Weight	0.01	0.01	0.00
	(0.02)	(0.02)	(0.02)
Overweight	0.00	-0.01	-0.00
	(0.02)	(0.02)	(0.02)

*Note: Coefficients are from unique linear and logit fixed effects models. The estimation sample (N) comprises those 10,011 children with at least two measurements on weight. Control variables are included for maternal age, education, marital status, year and location (urban or rural). Standard errors are clustered to allow for correlation within individuals. The number of observations varies by the weight measure considered. Standard errors are reported. † p< .10, * p<0.05, ** p<0.01, and *** p<0.001. CDC percentiles are converted to z-scores to maintain equivalence across measures.*

6.3. Controlling for childcare.

I did not include childcare in the main analysis due to concerns of potential endogeneity. The exact relationship between parental unemployment, childcare and children's weight is unclear. Children in care may have different dietary and exercise habits than children outside of care. If these are positive, i.e. a healthy diet or a schedule of exercise, this may cushion children against the effects of unemployment on weight. Alternatively, the quality of diet and exercise in the childcare setting may be inferior, and thus could negatively influence child weight. However, childcare may also lie on the causal pathway between unemployment and child weight, i.e. parental unemployment may make childcare unaffordable, thus removing its positive or adverse effects. Childcare may, therefore, be endogenous. In Table 6, I repeat the main analysis in Table 2, controlling for childcare status.[8] Results indicate that, despite the inclusion of the childcare control, conclusions on the magnitude and direction of the association between parental unemployment and child weight are largely unchanged. I interpret the consistent results, with and without controlling for childcare, as an indication of the limited influence of childcare on the association between unemployment and child weight in my analysis.

Table 6:
Parental Unemployment and Child Weight
(Controlling for childcare effects)

	Either Parent Unemployed	**Father Unemployed**	**Mother Unemployed**
BMI (WHO)			
Z-score	0.05*	0.04	0.05
	(0.02)	(0.03)	(0.03)
Healthy Weight	0.00	-0.02	0.03
	(0.02)	(0.02)	(0.03)
Overweight	0.06**	0.06*	0.04
	(0.02)	(0.03)	(0.04)
Weight for height (WHO)			
Z-score	0.05*	0.03	0.06†
	(0.02)	(0.02)	(0.03)
Healthy Weight	-0.03	-0.04	0.02
	(0.02)	(0.03)	(0.04)
Overweight	0.03	0.04	0.00
	(0.02)	(0.03)	(0.04)
Weight for age (WHO)			
Z-score	0.03*	0.02	0.04

[8] A subgroup analysis may be an alternative means of evaluating the importance of childcare. However, as a proportion of household income, Ireland has one of the highest costs of childcare across the OECD. Thus, a comparison of outcomes in children stratified by childcare status diminishes to an analysis stratified by wealth, obscuring the importance of the childcare effect (Russell et al., 2018).

	(0.01)	(0.02)	(0.02)
Healthy Weight	-0.04†	-0.06†	0.02
	(0.03)	(0.03)	(0.04)
Overweight	0.06*	0.06*	-0.00
	(0.03)	(0.03)	(0.04)
Weight for age (CDC)			
Z-score	0.03*	0.02	0.03
	(0.01)	(0.02)	(0.02)
Healthy Weight	-0.04†	-0.04	-0.00
	(0.02)	(0.03)	(0.04)
Overweight	0.05*	0.03	0.03
	(0.02)	(0.03)	(0.04)
Weight for age (UK)			
Z-score	0.04*	0.03	0.04
	(0.02)	(0.02)	(0.02)
Healthy Weight	-0.05†	-0.08*	0.02
	(0.03)	(0.03)	(0.04)
Overweight	0.07*	0.07*	0.01
	(0.03)	(0.03)	(0.05)

*Note: Coefficients are from unique linear and logit fixed effects models. The estimation sample (N) comprises those 10,011 children with at least two measurements on weight. Control variables are included for maternal age, education, marital status, year, location (urban or rural) and childcare. Standard errors are clustered to allow for correlation within individuals. The number of observations varies by the weight measure considered. Standard errors are reported. † p< .10, * p<0.05, ** p<0.01, and *** p<0.001. CDC percentiles are converted to z-scores to maintain equivalence across measures.*

6.4 Adjusting outcomes for pre-term and post-term births.

One potential concern in the identification strategy is that the influence of unemployment on weight may be biased by children of pre-term or post-term birth. The child growth charts used in this study quantify healthy and excess child weight using thresholds that depend on the children's age. However, child weight is expected to increase with a more extended period of gestation, and decrease with a shorter period of gestation (Bann et al., 2018; Cheung et al., 2016). Thus, children who are born post-term may appear heavier for their age than those who are born at term or pre-term, and vice-versa for pre-term children.

Until recently, the *zanthro* package for Stata was unable to transform raw child anthropometric data to standard deviation z-scores using gestationally adjusted age (Vidmar et al., 2013).

Likewise, child cohorts do not always contain information on the length of gestation. Thus, much of the comparable literature is based on a default gestational period of 40 weeks, i.e. an assumption of term births (Collaborators, 2017; Lobstein et al., 2004). To maintain the comparability of this study with the prevailing literature, in the core analysis of Table 2, children's age was similarly defined by the time elapsed since delivery (Grummer-Strawn et al., 2009; Oddo et al., 2016).

Using the updated *zanthro* package, and data on children's gestational age at birth, I repeat the analysis in Table 2, adjusting children's age based on their period of gestation.[9] Pre-term children have their age adjusted downwards, while post-term children have their age adjusted upwards. Consequentially, children who are born early are now matched to a younger reference age on the child growth charts and children who are born later are matched to an older reference age. Results are reported in Table 7 and are conclusively the same as Table 2.

Table 7:
Parental Unemployment and Child Weight
(Adjusted for term of birth)

	Either Parent Unemployed	**Father Unemployed**	**Mother Unemployed**
BMI (WHO)			
Z-score	0.04*	0.03	0.05
	(0.02)	(0.03)	(0.03)
Healthy Weight	0.00	-0.02	0.03
	(0.02)	(0.02)	(0.03)
Overweight	0.06**	0.06*	0.04
	(0.02)	(0.03)	(0.04)
Weight for height (WHO)			
Z-score	0.04*	0.03	0.05†
	(0.02)	(0.02)	(0.03)
Healthy Weight	-0.02	-0.04	0.02
	(0.02)	(0.03)	(0.04)

[9] I adjust children's age as follows: Adjusted age = actual age + (gestation at birth − 40), where all measures of age are in weeks (Vidmar et al., 2013).

Overweight	0.03	0.03	0.00
	(0.02)	(0.03)	(0.04)
Weight for age (WHO)			
Z-score	0.03*	0.02	0.03
	(0.01)	(0.02)	(0.02)
Healthy Weight	-0.04	-0.05†	0.03
	(0.03)	(0.03)	(0.04)
Overweight	0.05*	0.06†	-0.02
	(0.02)	(0.03)	(0.04)
Weight for age (CDC)			
Z-score	0.02†	0.02	0.02
	(0.01)	(0.02)	(0.02)
Healthy Weight	-0.05*	-0.06*	-0.01
	(0.02)	(0.03)	(0.04)
Overweight	0.06*	0.05†	0.02
	(0.02)	(0.03)	(0.04)
Weight for age (UK)			
Z-score	0.03†	0.02	0.03
	(0.02)	(0.02)	(0.02)
Healthy Weight	-0.06*	-0.08*	0.03
	(0.03)	(0.03)	(0.04)
Overweight	0.07*	0.08*	-0.01
	(0.03)	(0.03)	(0.04)

*Note: Coefficients are from unique linear and logit fixed effects models. The estimation sample (N) comprises those 10,011 children with at least two measurements on weight. Control variables are included for maternal age, education, marital status, year and location (urban or rural). Standard errors are clustered to allow for correlation within individuals. The number of observations varies by the weight measure considered. Standard errors are reported. † p< .10, * p<0.05, ** p<0.01, and *** p<0.001. CDC percentiles are converted to z-scores to maintain equivalence across measures.*

6.5 Adjusting results for attrition.

The sample of interest in this study is the n original children sampled in wave one and observed over the full T-year period (T = 3). However, due to attrition, it is only possible to observe $\sum_{i=1}^{n} T_i$ observations. Attrition is an inherent characteristic of panel data. Non-response exposes the analysis to potential bias; thus, the results may be contaminated by attrition related to the outcome. Likewise, attrition may be more concentrated among population subgroups. Thus, those who remain in the sample may no longer be characteristic of those initially sampled or may have different outcomes than those who have left. Failing to account for this non-response may result in misleading estimates of the association between unemployment and child weight (Jones et al., 2007).

In the GUI data, of the 11,134 children sampled, 10,011 provided at least two weight measures or 90%. Nonetheless, the 10% of children with only one weight measure could be systematically different than those with multiple weight measures. The Inverse Probability Weighting (IPW) estimator creates weights that can be applied to the outcome analysis, such that children who are most like the children who leave the sample are given a higher weight in the analysis, to compensate for similar children who are missing (Wooldridge, 2007). Unlike the longitudinal weights that are supplied with the GUI data, these IPW weights are model-specific.[10] I estimate the probability of being in the estimation sample using binary logit models that include the baseline values of all the regressors in the primary model, and children's initial height and weight, as directed by Jones et al., (2007). The inverse probability-weighted results, presented in Table 8, provide no evidence of a substantive difference to the results reported in Table 2.

Table 8:
Parental Unemployment and Child Weight
(Adjusted for attrition)

	Either Parent Unemployed	**Father Unemployed**	**Mother Unemployed**
BMI (WHO)			
Z-score	0.04†	0.03	0.04
	(0.02)	(0.03)	(0.03)
Healthy Weight	0.01	-0.01	0.04
	(0.02)	(0.02)	(0.03)
Overweight	0.06**	0.06*	0.04
	(0.02)	(0.03)	(0.04)

[10]The study provided weights are inappropriate for many panel applications, because they refer to a balanced sample of individuals present since the initial wave (Thornton et al., 2013). The GUI weights will thus decrease the number of observations if applied to the analysis of an unbalanced panel or to a pooled pair of transitions that appear during the panel (Solon et al., 2013; Winship & Radbill, 1994). Most importantly, the IPW weights are designed explicitly for the outcome of interest, and to address the potential problem of non-response bias in this study-specific analysis (Jones et al., 2007).

Weight for height (WHO)			
Z-score	0.04*	0.02	0.05†
	(0.02)	(0.02)	(0.03)
Healthy Weight	-0.03	-0.03	0.01
	(0.02)	(0.03)	(0.04)
Overweight	0.03	0.03	0.01
	(0.02)	(0.03)	(0.04)
Weight for age (WHO)			
Z-score	0.03*	0.02	0.03
	(0.01)	(0.02)	(0.02)
Healthy Weight	-0.04	-0.06†	0.02
	(0.03)	(0.03)	(0.04)
Overweight	0.05†	0.06†	-0.01
	(0.03)	(0.03)	(0.04)
Weight for age (CDC)			
Z-score	0.03*	0.02	0.03
	(0.01)	(0.02)	(0.02)
Healthy Weight	-0.05*	-0.04	-0.01
	(0.02)	(0.03)	(0.04)
Overweight	0.05*	0.03	0.03
	(0.02)	(0.03)	(0.04)
Weight for age (UK)			
Z-score	0.03*	0.02	0.03
	(0.02)	(0.02)	(0.02)
Healthy Weight	-0.05†	-0.07*	0.02
	(0.03)	(0.03)	(0.04)
Overweight	0.06*	0.07†	0.01
	(0.03)	(0.03)	(0.05)

*Note: Coefficients are from unique linear and logit fixed effects models. The estimation sample (N) comprises those 10,011 children with at least two measurements on weight. Control variables are included for maternal age, education, marital status, year and location (urban or rural). Standard errors are clustered to allow for correlation within individuals. The number of observations varies by the weight measure considered. Standard errors are reported. † p< .10, * p<0.05, ** p<0.01, and *** p<0.001. CDC percentiles are converted to z-scores to maintain equivalence across measures.*

7. Discussion.

In this paper I examine the association of family economic conditions and the anthropometric status of children using established growth standards and references using panel data. The results indicate that children whose parents become unemployed have a higher probability of being an unhealthy weight. These results are contrary to those reported by the previous literature using cross-sectional data, which finds little evidence for an association between unemployment and child weight (Gwozdz et al., 2013) or an increase in the prevalence of infant underweight with increased local unemployment (Bellés-Obrero et al., 2016). However, my results are consistent with research which reports that increased aggregate-level (state) unemployment is associated with increased adiposity in children in panel studies (Böckerman et al., 2007; Charles & DeCicca, 2008; Currie et al., 2015; Oddo et al., 2016). Ruhm (2005) describes the use of longitudinal data in fixed effects models as the ideal study design for identifying the effects of economic change on health. Similar research indicates that this identification strategy restricts potential sources of confounding, a limitation of cross-sectional studies, and thus improves the identification of causal effects (Oddo et al., 2016). To my knowledge, this is the first longitudinal study to investigate the impact of parental unemployment on the weight of young children using individual level unemployment data.

The literature suggests that unemployment driven adiposity in young children is primarily a function of income effects and changes in the opportunity cost of time (Bellés-Obrero et al., 2016). To consider the potential influence of these effects, I examine the relationship between parental unemployment and physical activity and diet. The results show a lower probability of a healthy diet and physical activity involving a cost among children whose parents experience unemployment, although establishing a causal relationship using this cross-sectional outcome data is not possible. Consistent with my results, Bellés-Obrero et al. (2016) find that unemployment is significantly related to an unhealthy diet for children in the same age-group in Spain. However, they report that exercising increases with regional unemployment, although physical activity is measured differently in their study, and may capture unpaid exercise.

Few studies to date focus on children in the early years of life, Gwozdz et al. (2013) measure children aged 2–9 years old, Bellés-Obrero et al. (2016) analyse children aged 2 to 15 years old and Oddo et al. (2016) consider children aged 7–18 years. The age distribution of the GUI children, 9-months, 3 years and 5 years old, increases the accuracy of the adiposity measures by analysing weight before puberty and its accompanying body changes (Anderson et al., 2003). Likewise, the use of established growth charts provides reliable thresholds to define an unhealthy weight by the age and gender of the child (Grummer-Strawn et al., 2009). This age range similarly supports an analysis of the parental channel of effect as, before adolescence, young children have less of a role in determining the composition of their diet and their leisure activities (Anderson et al., 2003).

A comparison of the effects across studies is confounded by which interpretation of excess weight is adopted (Vidmar et al., 2013). In this study, the appropriate application and interpretation of anthropometry in infancy and childhood is informed by the WHO, British Growth Reference and the CDC growth charts. One of these three weight references appears in nearly all published studies of child weight, increasing the comparability of my study in the literature (Rajmil et al., 2014). Ultimately, I derive three commonly used anthropometric indices from height and weight measurements compared with reference curves: BMI, weight-for-age, and weight-for-height. Although related, they all reflect different combinations of biological processes and outcomes in children, and cannot be used interchangeably (Organization, 1995). The study results are robust to adjusting children's age for term of birth, the application of supplementary "placebo" regressions, extension of the identification strategy, and the reweighting of the data to represent children who have left the sample. Finally, the timing of the GUI data provides the opportunity to use the recession as a natural experiment and provides unique variation in the unemployment rate, variation that is not present in studies of child weight that precede the recession (Anderson et al., 2003; Aris et al., 2018; Gwozdz et al., 2013).

The limitations of this study should also be noted. I can not control for paternal characteristics without removing single mothers from the estimation sample, and thus biasing results away from more economically vulnerable children. Also, my analysis of the association between maternal unemployment and child weight is hindered by a labour force attachment in Irish mothers that is traditionally much lower than in Irish fathers (Briody et al., 2020). Finally, my findings may capture changes in social norms and a larger 'recession mentality'; however, year fixed-effects should absorb variation for common shocks across years, while my placebo treatment test provides no evidence that a secular trend in weight gain is driving my results (Mincy & De la Cruz Toledo, 2014).

8. Conclusion.

The incidence of adiposity in children in the early years of life has outgrown the prevalence rate in older children and adolescents globally; however, few studies have considered weight outcomes in this age group due to a lack of established anthropometric measures (Collaborators, 2017). Similarly, the WHO reports that insufficient surveillance data exists on height and weight in the first five years of life for European children, a finding mirrored in US studies of same-aged children (Cheung et al., 2016; Jones et al., 2017).

For Irish children, there is rich panel data on children's physical development and economic status in the first five years of life (Collaborators, 2017). I analyse the relationship between parental unemployment and child weight, and the association of parental unemployment with weight-sensitive behaviours. The results indicate a greater association of excess weight, unhealthy weight, and poor diet and physical activity in children whose parents experience unemployment. This suggests that efforts to prevent excess weight in children could target the children of unemployed parents. Results may similarly suggest that diet and physical activity which requires a financial investment are potential mechanisms to consider in any such interventions.

As overweight children tend to grow into overweight adults, to prevent this and other related illnesses in adults and adolescents, it is essential to understand the causes of excess weight in children (Anderson et al., 2003). In Irish children, there is preliminary evidence to indicate that overweight children are already developing comorbidities. A study of more than 1,000 Irish children found that 8% of children had high blood pressure, with twice as many overweight/obese children classified as having high blood pressure when compared to healthy-weight children (Loughnane & Murphy, 2015). Likewise, the greatest metabolic risk and BMI is seen in Irish adults who were overweight in the first five years of life (Perry et al., 2017). If these trends are not addressed a generation of children may grow up with a higher incidence of chronic disease.

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Appendix.

Table A1:
Weight Cut-offs

BMI (WHO)	
Healthy Weight (BMI)	Z-score > -2 SDs & <1 SDs.
Overweight (BMI)	Z-score > 2 SDs.
Weight for Height (WHO)	
Healthy Weight (Weight for Height)	Z-score > -2 SDs & <2 SDs.
Overweight (Weight for Height)	Z-score > 2 SDs.
Weight for Age (WHO)	
Healthy Weight (Weight for Age)	Z-score > -2 SDs & <2 SDs.
Overweight (Weight for Age)	Z-score > 2 SDs.
Weight for Age (CDC)	
Healthy Weight (Weight for Age)	Percentile > 5% & <95%.
Overweight (Weight for Age)	Percentile > 95%.
Weight for Age (UK)	
Healthy Weight (Weight for Age)	Z-score > -2 SDs & <2 SDs.
Overweight (Weight for Age)	Z-score > 2 SDs.

This table describes the overweight and healthy weight thresholds across the growth charts used in this study. Thresholds are informed by: (De Onis, 2015; Forouhi et al., 2019; Vidmar et al., 2013; Wang & Chen, 2012).

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