Understanding the Relationship between Psychological Problems and BMI Development: UK Millennium Cohort Study

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Introduction

For the UK's youth, the obesity and mental health crises are the country's most urgent health epidemics. However, they are not unrelated. Overweight and obesity have been shown to be associated with depression, a poor self-image, and low self-esteem, among other mental health problems (Davison and Birch 2001). Previous longitudinal studies have shown there to be a relationship between a range of psychological and social problems and overweight among children both in the UK (Griffiths, Dezateux et al. 2011, Kelly, Patalay et al. 2016), and beyond (Griffiths, Parsons et al. 2010, Sawyer, Harchak et al. 2011, Sanders, Han et al. 2015), however less is known about how this relationship changes as children age, and the factors that mediate the relationship between the two. This study uses a series of growth curve models with data from the UK's Millennium Cohort Study to analyse the relationship between psychological problems and children's BMI development. This study shall add to the existing literature in two ways. Firstly, this study will explore how the relationship between psychological problems and BMI changes as children age. Secondly, this study will consider whether the relationship between psychological problems and BMI is mediated by withdrawal from physical activity. Preliminary analysis confirms that psychological problems are associated with increases in BMI among children in the UK (Kelly, Patalay et al. 2016), and shows that those who possess psychological problems experience a higher rate of acceleration in BMI growth as they age, compared to those without psychological problems. Furthermore, this study controls for a range of perinatal, early life, and environmental factors, drawn from a theoretical framework that encompasses both an ecological approach to obesity and the developmental origins model (DOHaD).

Background

Many previous studies have found associations between psychological problems and childhood overweight (Griffiths, Dezateux et al. 2011, Sanders, Han et al. 2015, Kelly, Patalay et al. 2016). One study of a US cohort between the ages of 6-18 showed that transition into obesity from childhood to adolescence was associated with psychological and social problems compared to those who didn't undergo this transition (Huang, Lanza et al. 2013). A UK-based study used cross-lagged models to assess the relationship between BMI and internalising symptoms, finding that the two become increasingly associated and reciprocal after the age of 7, with socioeconomic position attenuating some of the associations (Patalay and Hardman 2019). This study takes advantage of rich prospective data available in the UK to further explore the nature of the relationship between psychological problems and children's BMI development. By allowing the indicator of psychological problems to vary across time and including an interaction with age and a squared-term for age, the association between psychological problems and BMI can change across the developmental period.

The longitudinal relationship between psychological problems and overweight is regarded by many to be bidirectional, both exerting an influence on each other (Griffiths, Parsons et al. 2010, Preiss, Brennan et al. 2013). While assessing the complex causal relationship between psychological problems and childhood overweight is beyond the scope of this study, forthcoming analysis shall lag the variable for psychological problems behind BMI scores to explore how earlier psychological problems are associated with subsequent changes in BMI among children.

Additional factors may mediate the relationship between psychological problems and childhood overweight. Several authors have suggested that the relationship may be mediated by factors such as social stigma, isolation, and victimisation (Duarte, Sourander et al. 2010, Sawyer, Harchak et al. 2011, Kelly, Patalay et al. 2016). A study of children in Australia found that concern about weight and shape mediated links between weight status and a range of mental health indicators (Allen, Byrne et al. 2006). In addition, a number of cross-sectional studies have identified various factors such as severity of obesity, SES, body image, physical health, physical activity, interpersonal effectiveness, and eating disorders to be associated with the relationship between obesity and depression among adults (Preiss, Brennan et al. 2013). This paper shall add to existing literature on the relationship between psychological problems and BMI increases by exploring the hypothesis that this relationship is mediated by the withdrawal from physical activity that requires social engagement.

The developmental origins for health and disease was first proposed based on the finding that those who developed coronary heart disease possessed different patterns of growth in early life (particularly foetal life) (Barker, Osmond et al. 1989, Barker 2004). The DOHaD model has since been applied to gain a further understanding of how risk of obesity is determined by early life exposures (Thompson 2012). Maternal pre-pregnancy obesity and obesity during pregnancy (Benyshek 2007, Godfrey, Gluckman et al. 2010), maternal smoking during pregnancy (Gillman 2005, Benyshek 2007, Kuzawa, Gluckman et al. 2007), and the early feeding environment (absence of breastfeeding, early introduction solid foods) (Gluckman and Hanson 2004, Thompson 2012) are factors known to influence the development of overweight later in the life-course through biological, environmental and social pathways that shape growth patterns.

In Western societies, many changes have occurred which mean the environment within which children grow up can be characterised as one that encourages weight gain. The term ‘obesogenic’ has been used to describe an environment that promotes an unhealthy lifestyle through varying levels of availability and accessibility to certain foods, in addition to food marketing (Lake and Townshend 2006). The ecological model neatly incorporates environmental factors into a model that describes the process that shapes an individual’s risk of becoming overweight (Egger and Swinburn 1997). Environmental, biological, and behavioural factors influence changes in levels of body fat through their impact on energy intake and expenditure, which act as mediators. Previous studies have found environmental and contextual factors such as family income (Li, Goran et al. 2007, Danner 2008, Huang, Lanza et al. 2013), sedentary lifestyle (Reilly, Armstrong et al. 2005, Danner 2008, Brophy, Cooksey et al. 2009, Cecil-Karb and Grogan-Kaylor 2009, Goisis, Sacker et al. 2015), indicators of diet and family routine (Brophy, Cooksey et al. 2009, Goisis, Sacker et al. 2015, Kelly, Patalay et al. 2016), parental overweight during early childhood (Reilly, Armstrong et al. 2005, Hawkins, Cole et al. 2009), and parental perception of the local neighbourhood to be associated with childhood overweight (Lumeng, Appugliese et al. 2006, Ferrão, Gama et al. 2013). Reflecting upon both the ecological systems approach to obesity and the DOHaD model, this study adjusts for a range of proximal and distal confounders occurring across the life-course.

Data and Methods

This study uses data from the first six sweeps of the UK Millennium Cohort Study (MCS), a longitudinal study of children born into 19,243 families, sampled from all live births in the United Kingdom between September 2000 and January 2002 (Fitzsimons 2017). The MCS is a multidisciplinary study that contains a rich range of information regarding the experiences and outcomes of both the children and their families' (Connelly and Platt 2014). The first sweep of data was collected when cohort members were nine months old, and the subsequent five sweeps of data were collected at ages 3, 5, 7, 11 and 14 years.

This study uses the multilevel model for change to build individual BMI trajectories for MCS cohort members. The total difficulties score (TDS) is used as the indicator for psychological problems. This is derived from summing the scores from four of the subscales that belong to the Strengths and Difficulties Questionnaire, which is administered to parents in the MCS from sweep 2 onwards. It is coded into a binary variable for 'raised' (14-40) and 'close to average' (0-13) scores based on categories proposed by Youth in Mind (2016). A comprehensive set of confounders are adjusted for, reflecting the theoretical framework previously outlined. These variables are split into three groups: Perinatal and infancy period; early childhood characteristics; child, family and social environment. Preliminary analyses used log BMI as a continuous outcome variable, with concurrent total difficulties scores as the main explanatory variable. In preliminary analysis, growth curve models have been built using BMI data from the second sweep (age 3) to the sixth sweep (age 14).

Results

	Model	
Parameter	**Estimate**	**S.E.**
Intercept	2.810***	0.001
Age	-0.011***	0.000
Age^2	0.003***	0.000
SDQ total difficulties		
Raised	0.009***	0.002
Age * raised	-0.002**	0.001
Age^2 * raised	0.000***	0.000

Table 1: Fixed part for an unconditional growth model estimating BMI trajectories of children aged 3-14
Notes: ***p < 0.001, **p < 0.01, *p < 0.05.

Table 1 displays the results from the unconditional growth model ran as preliminary analysis, using log BMI as a continuous outcome variable, with concurrent total difficulties scores (and interactions) as the predictor variables. The estimate for the fixed part of the intercept provides the mean log BMI score at age 3, when all other predictors equal zero or their reference. This is 2.81, or approximately 16.6 in actual BMI [exp(2.81)]. The main effect of having a raised total difficulties score is small but statistically significant (p<0.001). It can be calculated that the BMI of an individual with a raised TDS is predicted to be 0.9% higher than those with a close to average score [100*(exp(0.009)-1) = 0.9%]. Both the interactions between having a raised TDS and age, and a raised TDS and the squared term for age are statistically significant (p<0.001). The interaction between the binary variable for

psychological problems and the slope is negative, and predicts that an additional year of age leads to a reduction in BMI for those with raised scores by around 0.2% [100*(exp(-0.002)-1) = -0.2]. However, this effect is offset by the positive association between total difficulties and the acceleration of children's BMI growth (squared term for age). As a result, those with raised total difficulties scores at age 11 are predicted to have BMI scores 0.9% higher than those children aged 11 without raised scores [100*(exp(0.009+(8*-0.0020)+(8^2*0.00025))-1) = 0.9], and for those aged 14 with raised scores this figure is 1.7%.

Discussion

The results of the preliminary analysis confirm previous associations between psychological problems and overweight among children in the UK (Griffiths, Dezateux et al. 2011, Kelly, Patalay et al. 2016), and beyond (Griffiths, Parsons et al. 2010, Sawyer, Harchak et al. 2011, Sanders, Han et al. 2015). Furthermore, the interactions between TDS and the squared term for age, reveal that the that relationship between psychological problems and children's BMI scores strengthen as they grow older. The results presented show that as children with raised total difficulties scores age, BMI growth accelerates. This demonstrates the complexity of the relationship between psychological problems and BMI development and suggests that there may exist potential factors mediating the relationship, causing this acceleration in growth. This sets the scene for the next stage of analysis, that will test the hypothesis that the acceleration in BMI growth among those who possess psychological problems is mediated by withdrawal from participation in sports and physical activities that require social interaction with other children.

Additional steps that shall be taken prior to the completion of this study include conducting a second round of analysis using a binary indicator for overweight as the outcome variable, in addition to lagged total difficulties scores. Using a categorical indicator for overweight as the outcome variable, as opposed to a continuous measure for BMI, is advantageous because it shows which characteristics are associated with overweight, rather than raised BMI scores which could still belong to the normal weight category. Furthermore, lagging the variable for psychological problems behind BMI scores will enable this study to explore how earlier psychological problems are associated with the subsequent development of overweight. Whereas the growth curve model conducted as preliminary analysis uses BMI data from sweep 2 (age 3) to sweep 6 (age 14), the starting point for the trajectories in the next stage of analysis will be sweep 3 (age 5), to allow the measure for psychological problems to lag.

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