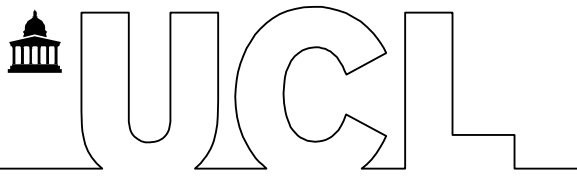

Psychosocial stressors in the home environment, obesity and socioemotional difficulties across the first decade of life: Findings from the Millennium Cohort Study

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Declaration of Authorship

I, Hanna-Marie Creese, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

There are a lack of studies which jointly examine psychosocial stressors in the home environment, socioemotional difficulties and obesity during childhood. This study examined two potential pathways of growing up in households characterised by psychosocial stressors on children's mental wellbeing and obesity across the first decade of life. First, the associations between psychosocial stressors, socioemotional difficulties and obesity were explored. Then, the patterning of socioemotional difficulties and BMI over time was examined.

Using the Millennium Cohort Study (MCS), cross-sectional and longitudinal logistic regression analysis was employed to analyse the associations for four family level psychosocial stressors (parental limiting longstanding illness, parental relationship change, parent-child conflict and maternal depression) with socioemotional difficulties and obesity at ages 3, 5, 7, and 11 years.

All psychosocial stressors were associated with increased odds of socioemotional difficulties, but associations between psychosocial stressors and obesity were found only for stressors pertaining to parental health (parental limiting longstanding illness; parental relationship change; maternal depression; and parent-child conflict). A significant interaction was found for parent-child conflict by parental relationship status, with children in single-parent families, compared to two-parent families, more likely to have socioemotional difficulties after exposure to parent-child conflict.

Finally, cross-lagged structural equation modelling was used to analyse the pathways between socioemotional difficulties and body-mass index (BMI) at ages 3, 5, 7, and 11 years, accounting for maternal and family characteristics and psychosocial stressors. For girls only, socioemotional difficulties and BMI were positively correlated in both directions from ages 7 to 11 years. Preadolescent girls with more socioemotional difficulties were more likely to have higher BMI's and similarly, girls with higher BMI's were more likely to have socioemotional difficulties.

Policies tackling child health in the UK should take a comprehensive approach to understand the mechanisms which lead to socioemotional difficulties and childhood obesity.

Impact Statement

Mental health difficulties are a substantial burden on the UK population, with one in four people suffering from a mental health problem at some point in their lives (World Health Organization, 2018). The cost of mental health for the NHS is higher than for any other disease (Centre for Economic Performance, 2012). A further significant health concern is the prevalence of obesity in high-income countries (World Health Organization, 2015), with the detrimental effects known to be an increased risk of developing chronic diseases such as Type II diabetes (Al-Goblan et al., 2014), coronary heart disease (Garrison et al., 1996), cancer (De Pergola and Silvestris, 2013) and stroke (Barrett-Connor, 1990). Therefore, identifying potential areas for prevention of obesity and mental health difficulties during childhood could decrease the burden of disease for individuals and economies.

Within academia, this research adds epidemiological evidence to the harmful impacts of psychosocial stressors on child health through the increased risk of obesity and socioemotional difficulties. Previous studies have limited analysis of stressors to singular exposures or as cumulative measures, but have not analysed the independent effects of multiple stressors (Trentacosta et al., 2008, Appleyard et al., 2005, Koch et al., 2008).

Furthermore, this thesis looks at the possible moderating influence of family structures and health behaviours, and how the relationship between adiposity and mental health patterns across childhood. Outside of academia, findings from this thesis are important to policymakers and healthcare professionals, as they lend support to an integrated approach to strategies aimed at reducing obesity and mental health difficulties during childhood.

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For my grandmother, whom I lost during this experience and who, given the opportunity, would have loved to complete her education.

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Chapter 1: Introduction

Two leading concerns for children's health in the UK today are obesity and mental health problems. The purpose of this thesis is to better understand the family psychosocial determinants of both during childhood and pre-adolescence. This introduction chapter summaries the current burden of mental health problems and obesity in childhood within the UK and outlines the thesis structure.

1.1 The burden of disease

Beginning with mental health, one in ten children suffer from a mental health problem such as depression, anxiety or conduct disorders (Mental Health Foundation, 2016). Half of all mental health problems are established by the age of 14 years (Kessler et al., 2005), with children in socioeconomically disadvantaged families at greater risk of suffering mental health difficulties (Mental Health Taskforce, 2016).

The multifaceted effects of mental health impact upon all areas of society, ranging across the life course: beginning at the start of life, children with mental health problems are more likely to leave school without qualifications (Breslau et al., 2008), have teen pregnancies and become dependent on drugs and/or alcohol (Lawrence et al., 2010, Kellam et al., 1980). Subsequently, adults with mental health problems are less likely to lead long, healthy lives. The devastating effects of poor mental health are no more poignant than that evidenced in the high levels of suicide observed in young men, with suicide being the leading cause of death for men aged 15 to 49 years (Mental Health Taskforce, 2016). This makes understanding risk factors for mental health problems in childhood of high importance (Jones, 2013).

Mental health problems are responsible for the largest burden of disease in the UK, almost twice of that due to all cancers or heart disease (Mental Health Foundation, 2015), with mental health accounting for 23% of NHS activity (Centre for Economic Performance, 2012). Mental health is the number one spending category in the NHS

(including dementia) (Nuffield Trust, 2014) and the estimated combined economic and social cost of poor mental health each year in England is £105 billion (Mental Health Taskforce, 2016).

Most recently, mental health has gained media attention after claims by the Association of Child Psychotherapists (ACP) that Child and Adolescent Mental Health Services (CAMHS) are failing to treat at-risk children (Association of Child Psychotherapists, 2018). The NSPCC has claimed that the number of children seeking support for anxiety is on the rise (NSPCC, 2016), with ChildLine, a non-profit organisation which supports vulnerable children, observing a 35% increase in counselling sessions about anxiety in 2016/17, with girls 7 times more likely to call than boys. Noted causes of anxiety range from personal and family issues to the effects of social media.

Over the last three decades, the worldwide prevalence of people who are overweight or obese has increased significantly (World Health Organization, 2002). A quarter of adults in the UK are clinically obese, and are therefore at an increased risk of developing chronic diseases. In the UK at ages 5-17 years, 22% of boys and 26% of girls are overweight or obese (based on International Obesity Task Force (IOTF) cut points) (Public Health England, 2015). Being overweight or obese substantially increases the risk of premature mortality (Pischon et al., 2008, Solomon and Manson, 1997) and lifetime morbidity (Masi et al., 2015, Leong and Wilding, 1999).

Fundamentally, obesity is caused by an energy imbalance when calorie intake exceeds energy output. However, coupled with an increased intake of energy-dense food, a decrease in physical inactivity due to the sedentary nature of many forms of work, changing modes of transport and growing urbanisation has led to an increased global burden of obesity (World Health Organization, 2015). The World Health Organisation (WHO) states that globally there are 42 million overweight children under the age of five (World Health Organization, 2015).

The obesogenic environment has been defined as “the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations” (Swinburn et al., 1999, p564.). Genetic susceptibility to the obesogenic environment may play a role in the propensity to become obese, but environmental factors, lifestyle features and culture are also influential via health behaviours (Wardle et al., 2008). Rather than just a form of nourishment, food is a marker of lifestyle which exposes children in more disadvantaged families in high-income countries to particular risk of becoming obese (Dehghan et al., 2005).

For example, in the UK those who are more disadvantaged are more likely to consume energy-dense foods (Drewnowski and Specter, 2004). The effects of frequent consumption of such foods are very difficult to counteract with physical activity (Styne, 2005). Obesity takes time to develop but the risks of becoming obese may start at the early stages of life (Lee et al., 2009).

In the UK, obesity has considerable effects on the economy. The Foresight Programme (2007) estimated the direct costs to the NHS of treating overweight and obesity at £4.2 billion in 2007. The indirect costs of obesity on the UK economy, such as through loss of productivity, were estimated at £15.8 billion (Butland, 2007). The Foresight programme also estimates that with the recent increase in the prevalence of obesity, by 2050 over half of the UK adult population could be obese, costing the NHS £10 billion a year (McPherson, 2007). Therefore a greater understanding of the causes of obesity is crucial to avert an increasingly obese population.

1.2 Thesis outline

This thesis enriches current literature on the social determinants of childhood obesity and mental health by firstly examining the relationship between psychosocial stressors in the family environment with obesity and socioemotional difficulties during childhood. Secondly, by building a greater understanding of the possible health behaviours and family structure which may moderate relationships. Lastly, by examining the way

mental health and obesity are associated with each other throughout childhood and pre-adolescence.

The structure of this thesis is as follows: the second chapter begins by introducing the socio-political context and theoretical underpinning behind this research, outlining concepts by Bronfenbrenner, Conger and Life Course epidemiology. The literature on the possible shared psychosocial stressors for obesity and mental health difficulties during childhood, and the potential pathways for this via home environment and health behaviours are discussed. The review goes on to propose that as childhood obesity and socioemotional difficulties may co-occur in households characterised by stress they should not be analysed in isolation of one another and that there is evidence to suggest that being obese may exacerbate socioemotional difficulties in children.

The third chapter builds on the literature review by summarising the conceptual framework that guides this study. The aim, objectives, and hypotheses are given. The fourth chapter introduces the dataset that is used for all analysis, the Millennium Cohort Study. The variables and general methodological issues are explained.

The fifth chapter is the first of four empirical chapters and describes the cross-sectional analysis of psychosocial stressors, socioemotional difficulties and obesity at repeated time points throughout childhood. Chapter Six looks at longitudinal analysis of psychosocial stressors with socioemotional difficulties and obesity. The seventh chapter tests the potential moderating health behaviours and family structures on the relationship between stressors and children's socioemotional difficulties and obesity. The final empirical chapter, Chapter Eight, looks at the longitudinal pathways between obesity and socioemotional difficulties during the first decade of life.

The thesis ends with an overall discussion chapter in which the study findings are summarised, the strengths and limitations are examined and the implications of the results within the wider socio-political context are discussed.

Chapter 2: Literature review

2.1 Introduction

There are a number of complex factors which may affect children's likelihood of socioemotional difficulties and obesity but this research is focused on the psychological, social and economic spheres within which children live. This PhD will analyse the association of four psychosocial stressors found in the home environment with socioemotional difficulties and obesity in childhood. The literature review first outlines the socio-political context and theoretical underpinnings of the study, then explores the possible shared psychosocial risk factors for the development of socioemotional difficulties and obesity in childhood. The review goes on to discuss the intricate relationship between markers of childhood obesity and mental health, and what other factors may go some way to explaining the relationship between stressors and children's health. This first section of the literature outlines the wider socio-political context for this research.

2.2 Socio-political context

In 2015, the Department for Health and the NHS published the Future in Mind report by the Children and Young People's Mental Health Taskforce which outlined best practice for access to services for children and young people (NHS England, 2015). It called for a fundamental shift in culture for children and young people's services to a whole system approach focusing on preventing mental ill health, early intervention and recovery.

Since the Future in Mind report, the independent Mental Health Taskforce published its Five Year Forward View for Mental Health in February 2016, which outlined a national strategy that covers care and support for all ages and is the first strategic approach to improving mental health outcomes across the health and care system, in partnership with arm's length bodies (Mental Health Taskforce, 2016). The NHS responded with an

implementation plan, and the Department of Health has supported the delivery of this plan with a £1.2 billion investment.

Building on Future in Mind, in December 2017, the green paper Transforming Children and Young People's Mental Health Provision was published by the government which puts schools and colleges at the centre of early intervention (Department for Health and Department for Education, 2017). To tackle early signs of mental health issues, every school and college is recommended to have a Designated Senior Lead for Mental Health providing a link between mental health services and education. Also proposed were Mental Health Support Teams managed jointly by schools, colleges and the NHS, which will provide extra capacity for interventions to support those with mild to moderate needs. The paper finally proposed a four week maximum waiting time for access to specialist NHS children and young people's mental health services.

In recent years there has been a greater stance by the government to encourage parity of esteem between mental and physical health, however, mental health difficulties remain a major concern for children in the UK today.

There are economic barriers to living healthily; one example of this is the cost of having a healthy diet. In real terms, between 2007 and 2016, the cost of food increased by eight per cent (Department for Environment Food and Rural Affairs, 2015) whilst salaries also decreased (Office for National Statistics, 2018). The average household spends 11% of their income on food (Griffith et al., 2015). However, for low-income households, the picture is worse, with families having to spend 16% of their income on food (Griffith et al., 2015). Food insecurity has been defined as uncertain ability or inability to procure food (Schroeder and Smaldone, 2015). Studies from the US have consistently shown evidence to support an association between food insecurity and obesity (Suglia et al., 2012, Dhurandhar, 2016). Thirty-six per cent of respondents to the 2005 Low Income Diet and Nutrition Survey said that they could not afford to eat balanced meals (Nelson et al., 2007); crucially this was before the economic recession. In 2013, an estimated 500,000 people relied on emergency food aid (Cooper and

Dumpleton, 2013), and yet the number experiencing food insecurity is likely to be much higher than those accessing food banks.

In an effort to combat population levels of overweight and obesity, the government has focused policies on diet and sugar intake (HM Revenue & Customs, 2016, Public Health England, 2014). With people on low incomes at greater risk of developing obesity, these economically driven policies to combat obesity have often hit disadvantaged people the most. One example of this is the taxation of high sugar products as part of the childhood obesity strategy published by the Government in January 2017. The Government announced a 24p per litre sugar levy, which was enforced in April 2018, making it more expensive to buy sugar-sweetened drinks (HM Revenue & Customs, 2016). The childhood obesity strategy further proposes product reformulation to reduce sugar content, the resizing of unhealthy foods, such as chocolate bars and a boost to physical activity funding in schools (Parliamentary Office of Science & Technology, 2016).

Another illustration of how economic deprivation is associated with obesity is the greater availability of unhealthy food in deprived areas (Cummins et al., 2005). Studies in the UK have identified that there are more fast food outlets in low-income areas (Maguire et al., 2015). The government has demonstrated some targeted subsidies to help families on low incomes eat more healthily with NHS administered Healthy Start Vouchers which can be exchanged for cow's milk, fruit, vegetables, and infant formula (Lucas et al., 2013). These vouchers are for pregnant women and young families with children under 4 years of age who are receiving benefits. However, the vouchers are worth very little (£3.10 a week for a pregnant woman) and are for a limited range of food. There are information barriers to this type of targeted intervention, as individuals need to be informed and know how to apply. Therefore, often those who would benefit the most show the least uptake (McFadden et al., 2014).

Under the New Labour administration in 1997, England became the first European country to pursue a systematic policy to reduce socioeconomic inequalities in health,

with a specific interest in reducing child poverty (Mackenbach, 2010). These policies would have been in place or coming into place, during the childhoods of the Millennium Cohort Study children. Although there was some success throughout this period, including a 10% reduction in inequalities in life expectancy and infant mortality, the strategy failed to reach its own targets (Mackenbach, 2010). A renowned commentator on health inequalities, Johan Mackenbach (2010), has analysed the multiple policies in the strategy and concluded that failures were seen as a result of ineffective policies that were not addressed on a large enough scale and at the correct entry points.

One error was that too much focus was placed on policies to tackle individual behaviour, rather than policies to tackle social determinants (Law et al., 2012). Examining the policies to tackle inequalities, Law and colleagues (2012) argued that this emphasis on individual responsibility for health, rather than confronting the disadvantaged environments which shape family behavioural choices should not be applied to childhood inequalities. Government policies aiming to combat obesity have been based on educating and informing the public on healthy behaviours, such as the 'Change4Life' social media campaign that was launched in 2009, which encouraged healthy eating and increased physical activity (Law et al., 2012). After its launch, over a million parents claimed to have made changes to their children's diet or activity levels. However, sustained effects on behaviour and attitudes may be limited by a lack of long-term engagement (Parliamentary Office of Science & Technology, 2016).

During the thirteen year period of the Labour administration, a further failing was that income inequalities which are associated, although not necessarily causally, with health inequalities were not the main focus of their strategy and remained unchanged or even widened during the administration (Mackenbach, 2010). Many of the policies they did publish were well into Labour's second term of office, meaning that often policies were implemented for only a few years.

A further recommendation by Law and colleagues (2012) on future approaches to tackling child health inequalities, is that policies include safeguarding accessible and

equitable health services for all; ensuring that child health professionals are well-versed on the causes of and solutions to child health inequalities; and that the research base on the extent and trends in health inequalities and the interventions to reduce them is built upon.

A recent report by the Institute for Fiscal Studies (2017), produced with funding from the Joseph Rowntree Foundation, states that if economic forecasts are correct, and the government were to stick to current plans for changes to welfare benefits, including the rollout of universal credit, absolute child poverty will increase by approximately 4 percentage points (Hood and Waters, 2017). Since the Great Recession, child poverty has risen from 27% in 2011 to 30% in 2018. With the change in policy, the UK could see childhood poverty increase by 34%, the highest in twenty years.

Although Mackenback (2010) concedes that reducing health inequalities is currently beyond our means, he argues that we should not accept health inequalities as inevitable, rather that reducing avoidable health inequalities is a moral imperative for many of us (Mackenbach, 2010).

2.3 Theoretical underpinning

This second section of the literature review outlines the theoretical underpinnings of the current study. It will discuss three key models of human development which form the foundation of the study's conceptual framework: Bronfenbrenner's bioecological model; Conger's Family Stress Model; and the Life Course approach to epidemiology.

Bronfenbrenner's bioecological theory of development extends his original model of human development, ecological systems theory (Bronfenbrenner, 1979), to recognise the importance of the individual and time (Bronfenbrenner, 2005). The theory puts the developing human at the centre of five interrelated, hierarchical systems of socialisation, moving from the most proximal to the most remote (Bronfenbrenner, 1986).

There are three elements which underpin Bronfenbrenner's bioecological theory of development: context; person; and process. Bronfenbrenner argues that human development consists of a set of processes through which aspects of the child and the environment interact to produce stable and evolving biopsychological characteristics over the life course (Bronfenbrenner, 2005). The characteristics of a child are the combined result of the surrounding environment and qualities of the child over the course of that individual's life. This theory of human development is applicable to both children and maturing adults.

The five hierarchical systems of socialisation are the microsystem; mesosystem; exosystem; macrosystem; and the chronosystem. The microsystem describes the immediate environment and factors that are most proximal to the developing child's day-to-day experiences. There is:

"… a pattern of activities, roles, and interpersonal relations experienced by the developing person in a given face-to-face setting with particular physical and material features and containing other persons with distinctive characteristics of temperament, personality, and systems of belief." (Bronfenbrenner, 2005 *pp.148)*

Social and physical institutions such as the family, home, school, peer groups and workplace exist within the microsystem. Interactions in the microsystem are not one-sided, with the personal characteristics of caregivers, family members and teachers having reciprocal influences on the child (The Psychology Notes HQ, 2013). How these groups or individuals interact with the child will affect how the child develops. In turn, how the child responds to the individuals in the microsystem will affect how they treat the child, with more nurturing and supportive interactions fostering improved child development.

The second system is the mesosystem which consists of the linkages and interchanges between the institutions in two or more settings in the microsystem. For instance, how the family and school interact will have differing effects on a child's development. If a child's parents are actively involved in the child's school, encourage children to take an interest in their education and get involved in school activities, then the child's

development will be positively affected through this harmony and like-mindedness. However, if there were difficulties in communication between parents and teachers, this might negatively impact on children's educational attainment.

The third system, exosystem, includes the interactions between two or more institutions that are more abstract to the child's day-to-day interactions, but affect them none the less, such as interactions between parents and his or her place of work. The institutions in the exosystem will not ordinarily contain the developing child but will affect their social environment and affect their development indirectly. For example, if a mother is experiencing work-family conflict this may make her a less responsive caregiver at home.

The macrosystem is the largest and most distant ecosystem to the developing child, consisting of the overarching pattern of the three preceding systems:

*"…which are characteristic of a given culture, subculture, or other broader social context, with particular reference to the developmentally instigative belief systems, resources, hazards, lifestyles, opportunity structures, life course options and patterns of social interchange that are embedded in each of these systems." (*Bronfenbrenner, 2005 *pp.149-150)*

This system is composed of cultural patterns and values which influences the child's dominant beliefs and ideas, as well as political and economic structures (The Psychology Notes HQ, 2013). Within the macrosystem, patterns of belief and behaviour are passed onto the individual through socialisation carried out by various institutions of society. Children in capitalist nations, for example, will develop differently to children in communist nations where different values and ideals reign.

Furthermore, the final system, the chronosystem, adds the important dimension of time to child development. Institutions such as the home may remain stable or change over time. For example, families might change address; family dynamics might alter or remain the same, and parental employment might vary during childhood. The chronosystem also encompasses the evolving socio-political context of societies.

All five systems are interrelated and simultaneously influence children's development. It is necessary to acknowledge and understand the interacting social spheres in the world

of a developing child. Interactions between children and their families are multifaceted and are influenced by surrounding social institutions and contextual factors. The main focus of this thesis is the microsystem of the family and how factors within the home environment could act as psychosocial stressors and affect children's development. I hypothesise that factors which are more proximal to children's day-to-day lives will have the greatest influence on their physical and mental health, with the caveat that factors in the four other ecosystems will also affect children's development in numerous ways.

Further to Bronfenbrenner's model, the Family Stress Model (FSM) helps explain how family characteristics and parenting behaviours are linked to children's outcomes, specifically within the context of poverty (Conger et al., 2010, Conger and Conger, 2002, Conger, 1994). The FSM asserts that experience of severe economic pressure threatens parents' mental health, affecting their relationships with co-parents and their behaviour towards children, which in turn negatively impacts on children's development. Within the home environment, parental distress may strain family relationships and disrupt parenting, ultimately threatening the physical and mental health of children.

Although the FSM focuses on the impact of economic stress and family functioning, a recent report by Masarik and Conger (2017) suggests that the model can be applied to various environmental stressors (Masarik and Conger, 2017). Symptoms of distress such as depression, can be felt by parents who are experiencing other stressors, for instance, chronic illness (Patten, 2001, Marrie et al., 2016, Moussavi et al., 2007); or bereavement (Maccallum et al., 2015, Galatzer-Levy and Bonanno, 2012).

In support of the FSM, Masarik and Conger (2017) illustrated how recent prospective studies (since 2012) have found associations between parent psychological distress and disrupted parenting behaviours in families with children aged two to ten years. Evidence in support of the FSM was found in different family structures and ethnic groups. Parents suffering from depression and/or anxiety were more likely to exhibit insensitive and unsupportive parenting practices and harsh parenting (Newland et al., 2013, Neppl et

al., 2016). Parents were also less likely to spend time doing activities with their children (Iruka et al., 2012).

Several recent studies support the hypothesis that disrupted parenting behaviours, which are often a result of parental psychological distress, are longitudinally linked to poorer child development. Children who have been exposed to disrupted parenting practices are more likely to suffer socioemotional difficulties such as externalising difficulties (Neppl et al., 2016, Simons et al., 2016, Shaw and Shelleby, 2014) and internalising difficulties (Landers-Potts et al., 2015, White et al., 2015, Zhang, 2014)

While the FSM is typically used to explain children's psychological, social and cognitive outcomes; recent studies using the FSM have found a link between disrupted parenting and children's physical health (McCurdy et al., 2010, Panico, 2012). McCurdy and colleagues argue that family stress increases children's risk of becoming overweight by way of parental behaviours. They hypothesize an association leading from poverty to maternal depression and parental food behaviours including food acquisition and management strategies culminating in food insecurity and children becoming overweight.

A final theoretical perspective which must be noted for influencing the conceptual framework of this research is the Life Course approach. Rather than an aetiological model like both preceding theories discussed here, the Life Course is a multi-disciplinary framework into which all explanatory models can be encompassed within (Bartley, 2017). The Life Course approach offers an explanation of the health gradient we see in population health research (Marmot, 2005), with the recommendation that this is a result of complex combinations of peoples' circumstances taking place over their lifetime (Ben-Shlomo and Kuh, 2002, Lynch and Smith, 2005).

Life Course epidemiology studies the biological, physical and social exposures which occur during all stages of life and can have long-term effects on chronic disease risk (Kuh et al., 2003). By understanding the biological and social factors which throughout

life independently, cumulatively and interactively influence health, the risks and protective processes of health can be identified (Ben-Shlomo and Kuh, 2002). Key to life course epidemiology is the consideration of temporal ordering of exposures and their inter-relationships within longitudinal analysis (Kuh et al., 2003).

One model within the Life Course approach is accumulation of risk, which originates from Riley's concept of insult accumulation (Riley, 1989). Riley's model suggests that every incidence of ill health or injury over the life course ultimately adds up to affect a person's mortality, regardless of their eventual cause of death. Even though studies have found powerful relationships between accumulation of risk and health outcomes, Bartley (2017) argues that the accumulation of risk model is often crudely generalised, with studies just adding up the hazards, regardless of time or type of hazard.

This model has led social epidemiologists to study the patterns of exposure to multiple risk factors, which are either independent or correlated and consequently quantify the cumulative effects of social determinants of health (Cable, 2014). For example, multiple studies have looked at the negative factors associated with maternal depression, finding that children of mothers with depression are more likely to be exposed to other family stressors such as low financial security, disadvantaged socioeconomic position (SEP), unemployment or marital conflict, with each subsequent factor having an adverse additive effect on health (Kiernan and Pickett, 2006, Reading and Reynolds, 2001).

It is also possible that repeated exposure to the same adversity across life can accumulate, negatively impacting on health outcomes. A longitudinal study of civil servants (Whitehall II), analysing the cumulative effect of common mental disorders on obesity risk found that compared with having a mental disorder at one time point, having repeat episodes increased odds of obesity, indicating a clear dose-response relationship (Kivimäki et al., 2009). Recognising the importance of the accumulation of risk model, the number of and timing of exposure to psychosocial stressors, as well as the number of times children are exposed to the same stressor over time are inquiries central to the current study.

Having outlined the theoretical underpinnings of this PhD, the next section of the literature review will examine in detail how psychosocial stressors in the home can affect children's risk of socioemotional difficulties and obesity.

2.4 Psychosocial stressors in the home environment

Psychosocial stressors can be defined as adverse conditions in the surrounding social environment which place demands on a person that exceed their psychological capabilities (Danielsson et al., 2012). Sources of psychosocial stress in early childhood most commonly occur in the home environment via the family or physical environment (Appleyard et al., 2005). As young children are dependent on caregivers, stress experienced by parents can feature in the day-to-day lives of children and negatively impact on their development (Nelson et al., 2009).

Chronic stressors in childhood, which expose children to strain over prolonged periods of time, have been found to predict negative, long-term effects on development (Shonkoff and Garner, 2012, Miller et al., 2011). For example, chronic exposure to stress hormones in early life can impact on the development of emotional function (Lupien et al., 2009). Experiencing a chronically stressful family environment during childhood, especially those in which frequent occurrences of conflict and disruption take place, can lead to deficits in emotional processing, social competence, and behavioural self-regulation, and over the life course can ultimately manifest in long-term mental and physical health problems (Repetti et al., 2002).

Socioemotional difficulties are defined as social, emotional, and behavioural problems, including externalising and internalising behaviours (Goodman, 1997). Externalising disorders are characterised by disruptive behaviours directed to an individual's environment which impair day-to-day functioning. Often externalising disorders are referred to as conduct, hyperactivity, and inattention problems (Goodman, 1997). In comparison, internalising disorders manifest as emotional, peer and relationship problems, with individuals internalising their maladapted emotions. Both externalising

and internalising difficulties are highly correlated with, and predictive of, mental health in adulthood (Loth et al., 2014). Early childhood socioemotional difficulties impact upon children's academic capacity and consequentially a number of outcomes into adulthood, including educational attainment, employment, and health inequalities (Duncan and Brooks-Gunn, 1997). Understanding inequalities and explanatory factors associated with socioemotional difficulties in childhood are important when considering long-term effects across childhood, adolescence and adulthood (Hinshaw, 1992, Kokko and Pulkkinen, 2000, Goodman et al., 2015, Narusyte et al., 2017) and the benefits of early detection and intervention (Heckman et al., 2006).

With respect to the effects of stressors on children's mental health, a study using the Avon Longitudinal Study of Parents and Children (ALSPAC) (N=7,429) created a cumulative risk index summing eleven risk factors associated with maternal depression between birth and two years of age (including disadvantaged SEP, inadequate living conditions, family structure, maternal relationships, maternal characteristics and substance abuse). Logistic regression showed each additional risk factor resulted in a minimum of a twenty per cent increase in the odds of child socioemotional difficulties five years later (Barker et al., 2012). These findings are supported by other studies which have found high family adversity in early childhood was linked to the early onset of mental health problems in middle childhood (Blanz et al., 1991, Trentacosta et al., 2008) and adolescence (Appleyard et al., 2005). However, regression models showed that those missing from the study were more likely to experience life stressors, so results may be conservative. Both maternal depression and exposure to the cumulative risks remained significant predictors of externalising and internalising behaviours independent of each other. The study did not report which of the eleven risk factors had the strongest associations with child behaviour.

Turning to the effects of stressors on children's obesity, growing evidence suggests that psychosocial stressors in children's home environments should be treated as risk factors for childhood obesity. Studies from the US (Garasky et al., 2009, Strauss and

Knight, 1999, Stenhammar et al., 2010) have analysed the association between multiple psychosocial stressors in the home environment and childhood obesity. Their findings show exposure to stressors increases the risk of childhood obesity.

The behaviours of parents experiencing psychosocial stressors may be different from that of parents not experiencing stressors. Evidence suggests that during periods of stress, food choices can become less healthy (Oliver and Wardle, 1999, Torres and Nowson, 2007). People with symptoms of depression may eat more to distract or reduce negative feelings (Haedt-Matt and Keel, 2011, Wurtman and Wurtman, 1995) or suffer from a loss of appetite (Simmons, 2016). Stress may cause symptoms of depression which in turn may negatively affect eating behaviour and dietary patterns (Stice et al., 2005). Therefore, children in homes with high levels of stress may have affected diets and eating habits. As a result of stress, parents may also have less energy to be physically active with children and to facilitate active play and sport (Wemme and Rosvall, 2005, Walton et al., 2014).

US studies have observed associations between multiple stressors and BMI; they have commonly calculated total stress indexes for each child by summing between four and nine dichotomized stressors, and reported generally consistent findings that families exposed to a greater number of stressors are more likely to have children with high BMI (Garasky et al., 2009, Wells et al., 2010, Evans et al., 2012). For example, a study which analysed maternal reports of intimate partner violence; food insecurity; housing insecurity; maternal depression; substance abuse; and incarceration found after adjusting for socio-demographic factors, girls experiencing a high number of multiple stressors (greater than two factors) at age one year only or at three years only were over twice as likely to be obese compared with girls with no risk factors at either time point. However, the study found no cumulative effect of psychosocial stress on obesity and no significant association for boys (Suglia et al., 2012).

These findings have also been supported in a large (N=7,443) longitudinal Swedish cohort (Koch et al., 2008) which looked at family psychosocial stress and obesity in 5-to-6-year-old children. This study examined cross-sectional and longitudinal high stress, categorised as reporting stress in two or more domains of life out of four: serious life events (e.g. divorce or death of a parent); parenting stress; lack of social support; and parent worries. They found children subject to high stress were over twice as likely to be obese at age five years (International Obesity Taskforce (IOTF) classification), both cross-sectionally (OR, 2.1 95% CI 1.3-3.5) and longitudinally (from exposure at 2 years: OR, 2.6 95% CI 1.3-5.4). This study analysed purely psychosocial factors, instead of combining psychosocial and material factors as in other studies. The association between multiple stressors and childhood overweight was not explained by control variables such as parental BMI or education level; however, the study did not adjust for income, which could partly account for associations.

In summary, studies have found stressors have adverse associations with childhood mental health and obesity. However, there are a number of limitations to this literature. Firstly, psychosocial, economic and physical stressors were often grouped together, which as discussed in part one of this chapter is a common problem concerning accumulation of risk studies (Bartley, 2017). Secondly, studies did not report on which risk factors have had the greatest effects (Trentacosta et al., 2008, Appleyard et al., 2005). Thirdly, there is very little research on the relationship between multiple psychosocial stressors in the home environment and childhood obesity in the UK. Studies in the US have consistently found associations between multiple stressors and childhood obesity, often using a composite score method. Studies, however, do need to differentiate between the effects of psychosocial, economic and physical stressors, and analyse associations in a longitudinal setting with particular attention to the different developmental stages of childhood. The influences of economic stressors, such as financial insecurity, or physical stressors, such as poor housing quality, on children's mental and physical health will operationalise in ways that are different from

psychosocial stressors. For example, the physical barriers preventing children from playing in a safe environment because they live in a deprived area may negatively impact children's mental well-being and increase their propensity to gain weight (Pouliou et al., 2015, Masoumi, 2017). This thesis will further examine psychosocial stressors to understand which have substantive associations with childhood obesity and socioemotional difficulties. As demonstrated in this review, household dynamics are complex and psychosocial stressors often co-occur, therefore should not be analysed in isolation of one another.

There can be many sources of stress in children's lives, but this study focuses on stress from psychosocial sources. It is, of course, difficult to differentiate between psychosocial stressors and economic or material stressors. The stressors I will examine are all potentially rooted in socioeconomic disadvantage and the negative effects of which are exacerbated by economic or material disadvantage (Reading and Reynolds, 2001, Reising et al., 2013, Hardie and Landale, 2013, Barnett, 2008, Conger et al., 2010, Choi and Marks, 2011). This thesis focuses on four areas of psychosocial stress: parental limiting longstanding illness; parental relationship change; parent-child conflict; and maternal depression, which are now summarised in turn.

2.4. 1 Parental limiting longstanding illness

Limiting longstanding illness (LLI) is relatively common with a prevalence of thirteen per cent (average calculated from spreadsheet available from Office for National Statistics (2016a)) in women aged fifteen to forty-four years reported by the 2011 Population Census for Great Britain (Office for National Statistics, 2016a). Men of the same age had a lower prevalence of LLI with nine per cent reporting a long-term illness which limits their day-to-day activities in some way. The role of parental health on children's mental and physical health, independent of socioeconomic and health behaviours, is not well known. Research in this area is frequently narrowed to studies with small sample sizes, specific parental illnesses, low power and limited ability to control for confounding factors

(Korneluk and Lee, 1998). Research has also focused mainly on the impact of chronically ill parents on children's problem behaviour (Sieh et al., 2010), not on their physical health, and especially not on childhood obesity. The health behaviours and dynamics of families who have a parent experiencing a limiting illness may be different (Korneluk and Lee, 1998), conceivably with less healthy food choices and less time partaking in physical activity.

Some studies have shown the low social support and high psychosocial stress experienced by children whose parents have a limiting longstanding illness can have negative effects on children's physical and mental health (Quinn et al., 2014, Umberger et al., 2015). A study looking at parental self-rated health in the Millennium Cohort Study (MCS) showed children whose main carer had poor health were more than four times as likely to have high socioemotional difficulties at age five years compared to children whose carers were in the best health group (Kelly and Bartley, 2010). The same study found poor parental health was associated with greater odds of obesity; however, this was largely explained by family health behaviours and social disadvantage.

In support of Kelly and Bartley (2010), another study using MCS found parents who self-reported poor health had increased odds of reporting poor health in their children (Sumilo et al., 2013). It could be that as an artefact of parental illness, parents are more likely to perceive their children's health as poor. However, the literature shows a mother's ratings of her child's health can be related specifically to the child's morbidity, independent of her own health and environmental health (McCormick et al., 1989). A way to eliminate potential reporting bias would be to use a more objective measure of health, such as medical diagnosis. Rather than parental self-reported health by way of a Likert scale, which is commonly used, limiting longstanding illness asks participants if their diagnosed, longstanding condition limits their activities in any way. The literature lends support to the need for further research on how parental limiting longstanding illness impacts on children's mental and physical health.

2.4. 2 Parental relationship change

Children who have experienced a serious life event are at greater risk of psychological, behavioural and somatic complaints (Compas, 1987). Studies analysing the effects of cumulative stress have often used a serious life events scale creating a composite measure, which is then added to an inventory of other stressors. Such studies have found associations between cumulative risk and childhood obesity (Evans et al., 2012, Koch et al., 2008). However, less research has looked at the effects of serious life events as a singular risk factor for childhood obesity. Nevertheless, associations between parental divorce and body dissatisfaction (O'Connor et al., 2016) and disordered eating (Suisman et al., 2011) have been found.

Specifically, parental divorce has been characterised as a serious event in the lives of developing children and has been associated with children's lower academic achievement, subjective well-being, self-esteem and social relations and increased behavioural difficulties (Amato, 2001, Størksen et al., 2005, Størksen et al., 2006, Cherlin et al., 1991).

In a review by Amato and Keith, effect sizes for the association between parental divorce and lower academic achievement, conduct problems, low self-concept, and poorer mother-child relations had all reduced over time from the 1950s to the 1980s (Amato and Keith, 1991). They hypothesised this was due to an increase in studies with improved methods. An alternative reason is that divorce has become more normative (Office for National Statistics, 2017).

Studies of children and divorce in the 1990s increasingly used more prospective, longitudinal data sets making it possible to control for pre-divorce socioeconomic factors and relationship characteristics. In addition to methodological advances, the effects of divorce on children might have become weaker due to less stigmatisation surrounding divorce, greater support for parents through mediation and school-based interventions resulting in less family conflict (Emery, 1999).

In an update of the 1991 review by Amato and Keith, many of the earlier findings that compared to children with continuously married parents were reinforced (Amato, 2001): children of divorced parents in the 1990s were significantly more likely to have lower scores on measures of academic achievement, conduct, psychological adjustment, self-concept, and social relations. Amato (2001) argues one possible explanation for the observed effect of divorce is the economic gap between children with single-parents and children with married parents (Burtless, 1999). Nonetheless, studies continue to find associations between parental divorce and child outcomes after adjustment for income (Mooney, 2009). Cherlin and colleagues (1991), argue the negative effects of parental relationship breakdown on child adjustment is due to three key factors which are involved in the provocation, process and result of relationship breakdown. They are the psychological health of parents; marital conflict; and financial difficulties (Cherlin et al., 1991).

The number of divorces (101,055 in 2015), and marriages (247,372 in 2014), of opposite-sex couples, has been at its lowest in England and Wales for more than 40 years (Office for National Statistics, 2017). This may in part be due to the increasing number of couples choosing to cohabit rather than entering into marriage (Beaujouan and Ni Bhrolchain, 2011). In 2011, 53% of all births were registered to married parents, compared to 60% in 2001 and 94% in 1961 (Office for National Statistics, 2013). Relationships of cohabiting parents have been found to be more unstable than that of married parents, with cohabiting parents much more likely to separate (Osborne et al., 2007). A separation of cohabiting parents could be just as emotionally upsetting as that of divorced parents. Negative outcomes have been found for children amongst those whose biological parents have split up, regardless of formal marital status (Goodman, 2010).

It is common for parents with young children to go through a relationship transition. Panico and colleagues, using the MCS found just under twenty per cent (19.7%) of families went through a change during the first five years of a child's life. The most common family change was to go from cohabiting to married (6.1% of families), then

married to single-parent (4.3%). They found a number of social, economic, demographic and well-being differences across family typologies (Panico et al., 2010). Continuously married parents were the highest earners, while continuously single-parents had the lowest income.

In addition to an increase in cohabiting families over recent decades, different family forms have grown in number to include blended (consisting of a couple and their children, and their children from previous relationships) or stepfamilies and single-parents (Connelly et al., 2014). Any relationship change parents go through could be potentially stressful for children too. Evidence from studies analysing blended families has shown children in blended families are on average more likely to have adjustment difficulties (Kirby, 2006a, Dunn, 2002, Dunn et al., 1998). This shows any parental relationship change may have profound effects on child adjustment.

2.4. 3 Parent-child conflict

Family relationships characterised by hostility and conflict are well documented to have damaging effects on children's mental and physical health, and studies suggest lasting effects into adulthood (Afifi et al., 2013, Afifi et al., 2012). The parent-child relationship is one of the earliest and most salient relationships that children are exposed to, with early discordant parent-child relationships serving as a model for the development of dysfunctional social behaviour (Weaver et al., 2015). Weaver and colleagues (2015) define parent-child conflict as an aspect of the parent-child relationship that is characterised by discordant or acrimonious interactions during which both the parent and child display negative behaviours. They note that there is an overlap between parent-child conflict and harsh parenting, as both include the expression of negative parental affect, intrusive behaviours, and even aggression.

The negative effects of parent-child conflict, characterised by harsh discipline, on child and adolescent mental health have been well documented (MacKenzie et al., 2013, Marmorstein and Iacono, 2004, Burt et al., 2003). There is substantial international

evidence that physical punishment, in particular, has the potential to damage children (Heilmann et al., 2015). In a review for NSPCC Scotland, Heilmann and colleagues (2015) found that the prevalence of physical punishment has declined over recent decades, with parents finding it less acceptable. After reviewing 74 longitudinal studies, which included observational, gene-environment and experimental designs, Heilmann and colleagues conclude there is strong evidence that physical punishment is associated with increased childhood aggression, antisocial behaviour, and symptoms of depression and anxiety, even in households where maternal warmth was considered to be high (Heilmann et al., 2015).

The Strauss Conflict Tactics scale is the most widely used instrument for identifying domestic violence (Strauss and Douglas, 2004). The parent-child version of the scale measures physical and psychological maltreatment of children (Straus and Hamby, 1997). Using data from the MCS, Kiernan and Huerta (2008) tested a family stress model hypothesis cross-sectionally by examining the indirect effects of economic deprivation and maternal depression via disciplinary practices, as measured by the items from the Conflict Tactics scale (smacking and shouting), at age 3. The study found that some of the association between maternal depression and children's behaviour was explained by depressed mothers exhibiting harsher disciplinary practices. The Conflict Tactics measures were strongly associated with more externalising (0.46 standard deviation increase, $p<0.001$), and more weakly with internalising difficulties (0.06 standard deviation increase, $p<0.001$), but not with measures of cognition (Kiernan and Huerta, 2008).

Other than physical punishment, parent-child conflict can also be captured by measures of family functioning (Miller et al., 2000). Aspects of poor family functioning, including low communication, low behaviour control and high family conflict have been associated with a greater risk of being overweight or obese (Halliday et al., 2014). Halliday and colleagues (2014) found that in twelve of the seventeen studies published between 1990 and 2011 that they reviewed, there were significant associations between family

functioning and overweight and obesity in children aged three to seventeen years of age. However, most studies were cross-sectional (16 cross-sectional and 1 longitudinal). Of these studies, only two found a positive association specifically between family conflict and childhood obesity, and both had very limited sample sizes and did not control for potential confounders (Hooper et al., 2009, Hanson et al., 1990). For example, the study by Hooper and colleagues was only a pilot study, with a very small sample size (N=77), and looked at bivariate associations only.

Alternatively, studies have found associations between obesity and parenting styles (Gerards et al., 2011). A systematic review of thirty-six studies by Gerards and colleagues (2001) found that parenting characterised by reasonable demands and high responsiveness, compared to authoritarian or uninvolved and/or neglectful parenting, ate more healthily, were more physically active and had lower mean BMI (Sleddens et al., 2011). This highlights the importance of understanding the interactions between parental characteristics and behaviours and children's adiposity.

2.4. 4 Maternal depression

In addition to parental limiting longstanding illness, maternal depression has been found to have damaging effects on child development, principally cognitive and emotional well-being (Ashman et al., 2008, Lovejoy et al., 2000, Kiernan and Huerta, 2008) and to a lesser extent obesity (Ramasubramanian et al., 2013). From very early in life, studies have found children of depressed mothers are less responsive to facial and vocal expressions, are fussier, more inactive and have raised stress hormones (Cohn and Tronick, 1983, Brennan et al., 2008).

In the third MCS survey, when children were five years of age, forty per cent of MCS mothers reported receiving a diagnosis of depression or serious anxiety during their child's life, with eight per cent of mothers currently receiving treatment (Hansen and Joshi, 2008). Ethnic minorities, single mothers, and mothers in couples where both partners were not employed were more likely to have received a diagnosis. Inherent

individual characteristics, such as certain genes and polymorphisms that are associated with serotonin or catecholamine levels, have been associated with major depression and post-partum depression (Lohoff, 2010, Couto et al., 2015). However, there are also many social and economic factors associated with risk of maternal depression, such as socioeconomic hardship, being a single-parent, parental relationship quality, early parenthood, low educational attainment, substance use and criminal behaviour (Barker et al., 2012, Reading and Reynolds, 2001, Panico et al., 2014).

Children of mothers with depression may have a genetic risk of psychopathology and a prenatal susceptibility to the mother's condition (Pemberton et al., 2010). However, maternal depression also has powerful environmental implications within the family context. As outlined in the above paragraph, children of depressed mothers may be at greater risk of experiencing other stressors, which may, in turn, affect their adjustment. Studies looking at the pathway from maternal depression to children's adjustment have found depressed mothers may have less sensitivity and be withdrawn, which could lead to poor interactions between mother and child (Ashman et al., 2008). As a result of maternal depression, the home environment may not be conducive to optimal child development with a lack of stimulation and social support (Kaplan et al., 2009, Cummings and Davies, 1994).

Many studies have looked at how parental stress is associated with childhood obesity (Tate et al., 2015, Suglia et al., 2012, Stenhammar et al., 2010), but fewer have looked specifically at whether maternal depression is related to children's body mass index. One possible explanation for the association between maternal depression and childhood obesity is that depressed mothers have been shown to have unhealthy diets (Pina-Camacho et al., 2015) and that consequently, children of depressed mothers may have unhealthy diets (Gross et al., 2013, Pina-Camacho et al., 2015). A study using MCS found that, after controlling for potential confounders (socioeconomic characteristics, family support, education, employment, maternal BMI and longstanding limiting illness), maternal serious psychological distress was significantly associated with 59% higher

odds of children being obese at age three years. Although the sample was large (N=10, 465) and a number of potential confounding factors were controlled for, this was a cross-sectional analysis at one time point in early childhood.

Lampard and colleagues (2014), conducted a systematic review of nine prospective studies that had looked at chronic maternal depression and childhood obesity (Lampard et al., 2014a): four studies did not find an association between maternal depression and being overweight or obese (Ajslev et al., 2010, Wang et al., 2013, Lane et al., 2013, Grote et al., 2010). The majority of studies looked at exposure at six months postpartum (n=6) and no study looked at exposure past eight years of age. The review found that family characteristics and health behaviours, which may moderate relationships, needed further investigation, as did the time of exposure. There was evidence that mothers with depressive symptoms were more likely to allow children to consume sweetened drinks, and less likely to set limits on food consumption or to eat breakfast with their children (Gross et al., 2013).

There is also evidence that depressive symptoms can lead to a decrease in appetite (Simmons, 2016) and positive associations have been found for maternal depression and children's underweight and stunting (Santos et al., 2010, Surkan et al., 2014). However, many of these studies are based in developing countries, where the relationship between maternal depression and children's dietary patterns are subject to altered food environments and possible food scarcity (Surkan et al., 2011).

The effects of paternal depression on child health are less well understood, with research and interventions tending to focus on maternal mental health (Wong et al., 2016, Panter-Brick et al., 2014). There is growing evidence that paternal depressive symptoms are associated with child development, largely with children's socioemotional measures (Ramchandani et al., 2008a, Ramchandani et al., 2008b), whereas research has shown that fathers' involvement can help prevent childhood obesity (Wong et al., 2017). It is reasonable to assume that paternal depression might have some effect on caregiving

and family functioning (Ramchandani et al., 2011), and consequently childhood BMI. In MCS, the prevalence of paternal depressive symptoms was 3.6% at 9 months, which alongside maternal depression decreased over time (2.0% at age 7 years) (Nath et al., 2016).

Turning now to children who may have experienced stressor at more than one time point, a number of studies have looked at repeated measures of maternal depression (Ashman et al., 2008) and parental limiting longstanding illness (Korneluk and Lee, 1998) on both mental and physical measures of child health. Fewer studies have looked at repeated measures of parent-child conflict, tending more often to rely on items indicating the frequency of conflict (Fosco and Grych, 2008). Even fewer have looked at multiple parental relationship changes (Amato, 2005). Research demonstrates associations between these four areas of psychosocial stress (parental limiting longstanding illness; parental relationship change; parent-child conflict; and maternal mental health), childhood socioemotional difficulties and obesity. It is important not to assess the relationship between one stressor and childhood obesity or socioemotional difficulties in isolation from other psychosocial stressors. The following sections review the literature on the relationship between being overweight or obese and mental health in childhood.

2.5 Childhood obesity and mental health

As discussed above, psychosocial stressors have been associated with both increased risk of childhood obesity and socioemotional difficulties, potentially by affecting the home environment, family functioning, stress hormones and health behaviours. Therefore, it is possible that childhood obesity and socioemotional difficulties may co-occur in households characterised by stress. The current section discusses how being overweight or obese may exacerbate socioemotional difficulties in children.

From a very young age, children who are overweight or obese may have a negative self-image, which may then affect their mental health and subsequently increase their risk of socioemotional difficulties. Cross-sectional studies have found overweight

children from as early as 5 years of age, have higher levels of psychological distress and low self-esteem (Gibson et al., 2008, Swallen et al., 2005). This may be in part due to the social stigma associated with being overweight or obese (Puhl and Heuer, 2010). For example, a cross-sectional study from the US by Swallen and colleagues (2005), using the National Longitudinal Study of Adolescent Health (N=4,743), found that in young adolescents (aged 12-14 years), being overweight or obese had harmful effects on mental health via self-esteem, depression and social functioning. Overweight and obesity had no effect on older adolescents' psychological health (Swallen et al., 2005).

A latent class analysis of BMI trajectories, using data collected at ages 3, 5, 7, and 11 years in MCS, found that children with "moderate increasing" and "high increasing" BMIs had worse scores for emotional symptoms, peer problems, happiness, body satisfaction and self-esteem at 11 years (Kelly et al., 2016). A limitation stated by authors was that they could not rule out, nor were able to tease out, a bidirectional relationship between BMI growth and socioemotional well-being. Social stigmatisation, isolation, and victimisation were hypothesised as unmeasured factors which may form this perceived link between overweight and socioemotional difficulties.

A prospective study in Quebec (n=1,344) used a cross-lagged structural equation model to examine the direction of association between BMI and victimisation for children aged 3 to 10 years. After controlling for the within-time associations and family adversity, high BMI predicted an increase in the victimisation by peers experienced by girls (aged 6 years and above) and boys (aged 7 and 8 years of age). The study found obese girls were subjected to victimisation from as young as 3 years of age (Qualter et al., 2015).

A systematic review of the links between obesity and self-esteem and quality of life in children and adolescents found obese youth had consistently lower scores for global self-esteem and quality of life, compared to youth with healthy BMI (Griffiths et al., 2010). They examined studies of cross-sectional, longitudinal and intervention design

published after 1994. Six out of nine studies found lower global self-esteem in obese compared with healthy weight children and adolescents. Similarly, nine out of eleven studies using child self-report, and six out of seven studies using parental report, found significantly lower total quality of life scores in obese youth. There were no significant differences in the associations by age and evidence of differences by gender and ethnic group was limited (Griffiths et al., 2010).

These findings are consistent with other study findings; Cornette (2008) reviewed ten papers published from 1995-2005, four of which were based in the US and the rest in the UK (three) Europe (two) and Australia (one) (Cornette, 2008). Cornette (2008) found higher BMI was correlated with low self-esteem, but low self-esteem was not related to later obesity. Cornette argues this conflicting finding might be due to the heterogeneity of the studies. The emotional consequences of childhood obesity were consistently weaker for boys than for girls, with evidence of an association between obesity and low self-esteem much stronger in girls, especially in adolescent girls who had reported a loss of control in their eating. In addition, Cornette found that certain media and maternal influences had negative effects on girls' self-image and perceived physical and cognitive abilities. Cornette concludes that further research should examine the relationship between being obese and other measures of mental health in childhood and adolescence, such as depressive symptoms. More specifically, Cornette calls for researchers to examine the possible bi-directional association between obesity and mental health, focusing on longitudinal relationships and gender differences.

Griffiths et al (2011) used MCS (N=11, 202) to assess obesity and mental health in children aged three to five years. Adjusted cross-sectional analysis showed that at age three years obese boys had more conduct problems and obese girls had better prosocial behaviours compared to healthy weight counterparts. At age five obese boys had more conduct problems, hyperactivity and inattention problems and peer relationship problems compared to their peers, whilst obese girls had more peer relationship problems. In a longitudinal analysis, obesity at age three years in boys

predicted greater conduct problems and total difficulties at age five years after controlling for socio-demographic and maternal characteristics. After controlling for prior difficulties and weight status, associations were fully attenuated. This study shows children who are obese are at risk of increased socioemotional difficulties from a very young age (Griffiths et al., 2011).

An Australian study analysed the relationship between children's BMI and indexes of socioemotional well-being at ages eight to thirteen years using Pearson product moment correlations. They found linear associations between psychological distress and child BMI. Principle components analysis indicated in overweight/obese, but not healthy weight children, global self-worth clustered with body image and eating disorder symptoms (Gibson et al., 2008). However, as this was a small (n=329) cross-sectional study, the interpretation of the findings is limited.

As a caveat to this, it could be that the relationship also operates in the opposite direction, that having socioemotional difficulties increases the propensity to gain weight. An increased appetite can be a feature of depression (Pettit et al., 2006), and adolescents suffering from depression have been found to experience increased cravings for carbohydrate-rich foods (Arbisi et al., 1996). A study examining this direction of association found a lack of evidence to support the relationship from low self-esteem to later BMI (Hesketh et al., 2004). Using a prospective cohort of children (aged 5-10 years) in Australia (N=1,157), longitudinal analysis showed that while non-overweight children with low baseline self-esteem were more likely to become overweight or obese, but after accounting for baseline BMI z-score, poorer baseline self-esteem no longer predicted BMI 3-4 years later at follow up. In contrast, cross-lagged analysis by Qualter and colleagues (2015) found evidence of a bidirectional association between BMI and mental health. With short-term effects held constant, victimisation had a three and five-year influence on annual BMI changes for girls from age three years (Qualter et al., 2015).

Although a large proportion of children and adolescents are overweight or obese, the potential psychological impact associated with being obese is contentious (Wardle and Cooke, 2005), with the directionality of the association between childhood mental health and obesity requiring better understanding.

Having reviewed the literature on the relationship between being overweight or obese and socioemotional difficulties in childhood, the following two sections explore possible factors associated with stressors, socioemotional difficulties and obesity which may confound or moderate associations.

2.6 Possible confounding factors of the associations between psychosocial stressors, socioemotional difficulties and obesity.

2.6. 1 Family socioeconomic characteristics

There is evidence that children living in families that have a disadvantaged socioeconomic position (SEP) are at increased risk of suffering multiple stressors compared to children of parents with more advantaged SEP (Evans and English, 2002a). Therefore stressors may go some way to explain the established link between disadvantaged SEP and childhood socioemotional difficulties (Kelly et al., 2011). Also, in developed countries there is an established association between disadvantaged SEP and being overweight or obese (Pickett et al., 2005, Shrewsbury and Wardle, 2008, Goisis et al., 2015), with studies consistently observing socioeconomic patterning in BMI (McLaren, 2007, Sobal and Stunkard, 1989, Howe et al., 2011). The multifaceted relationship between SEP and BMI may partly be explained by those in disadvantaged economic positions having increased exposure to cheap energy-dense foods (Reidpath et al., 2002, Drewnowski and Specter, 2004) along with neighbourhood and community environments playing a contributing role in the development of obesity among children from disadvantaged families, with constraints to the built environment, a lack of play areas and after-school clubs and activities (Dunton, 2009, Papas et al., 2007, Jago et al., 2014). Therefore measures of SEP

should be considered as potential confounders of the relationship between stressors and childhood obesity.

Within Sociology, social class is defined as a multifaceted construct which represents the social and economic divisions that are observed in society (Bartley, 2017). When analysing health inequality, it is advisable to account for the construct of social class. To measure social class it is desirable to use a measure which is based on employment relations and conditions, such as the NS-SEC (Office for National Statistics, 2016b), rather than simply job type (Bartley, 2017). In addition to social class, it can be essential to control for measures of income to resolve residual confounding by material and economic differences (Lynch et al., 2000). Furthermore, parental education is a particularly influential factor on health from early childhood (Shrewsbury and Wardle, 2008). The association between parental education and health has been shown to increase with age and differ between genders (Novak et al., 2006, Howe, 2012).

2.6. 2 Maternal age

Maternal characteristics such as maternal age at birth, have been consistently associated with children's health, with delayed childbearing associated with better health and educational outcomes for children (Sutcliffe et al., 2012, Fergusson and Woodward, 1999, Mollborn and Dennis, 2012, Morinis et al., 2013). This association is often explained by the disadvantages often faced by younger mothers, with teenaged mothers being less likely to have higher education qualifications and having lower income (Falster et al., 2018). Sutcliffe and colleagues (2012), using the Millennium Cohort Study and the National Evaluation of Sure Start Study (a random sample of children in deprived areas), found that children with older mothers had fewer socioemotional difficulties. Analysis stratified by maternal age showed that compared with mothers in the oldest category (>33 years), children of mothers in the youngest category (<22 years), had higher mean socioemotional difficulties scores at ages 3 and

5 years. They found no association between maternal age and weight status once maternal BMI was adjusted for (Sutcliffe et al., 2012).

2.6. 3 Maternal pre-pregnancy BMI

Maternal pre-pregnancy BMI has been associated with later child BMI (Castillo et al., 2015, Yu et al., 2013, Lawn et al., 2018) and to a lesser extent socioemotional difficulties (Jo et al., 2015), explaining some of the associations found between exposure to stressors and child health (Gundersen et al., 2008). A Brazilian prospective study by Castillo and colleagues (2015), looking at child body mass at age six years found that after adjustment for family socioeconomic factors, maternal characteristics and health behaviours, a one unit increase in maternal pre-pregnancy BMI was associated with a mean increment of 0.08 kg in children's body mass. Mothers with higher pre-pregnancy BMI were more likely to have children with greater adiposity at age six years (Castillo et al., 2015). This association between maternal and child BMI is supported in UK based cohort studies, with studies looking at the associations between child BMI and other health outcomes commonly adjusting for maternal pre-pregnancy BMI (Lawn et al., 2018, Zilanawala et al., 2015, Kelly et al., 2016).

2.6. 4 Sex and Puberty

Early puberty will be considered as a potential confounding factor in this research as the timing of puberty has been associated with both socioemotional difficulties (Mensah et al., 2013) and obesity (Daniels et al., 1997) in pre-adolescence and adolescence. Pubertal maturation is not uniform and happens at different ages and with different rates of development (Dorn, 2006). Studies examining the timing of pubertal maturation have shown an increased risk of socioemotional difficulties for children between early and post-puberty (Ong et al., 2018, Burnett et al., 2011).

Drawing on the evolutionary theory of reproductive development (Belsky et al., 1991), studies have found associations between pubertal timing and stressors (Wierson et al., 1993). Belsky and colleagues (1991) argue that a function of childhood development is to understand the availability of resources in the environment, the trustworthiness of others and the stability of interpersonal relationships, all of which influences how much the developing person allocates effort to reproduction (Belsky et al., 1991). Home environments characterised by maternal depressive symptoms and increased family disharmony have been associated with early pubertal maturation (Ellis and Garber, 2000, Ellis et al., 2011, Kelly et al., 2017).

Early menarche (aged 10-11 years) has been associated with both higher odds of socioemotional difficulties (Boden et al., 2011) and obesity (Bralic et al., 2012). Early sexual maturity in boys has also been associated with increased socioemotional difficulties (Kaltiala-Heino et al., 2003). However, compared to girls the associations between obesity and sexual maturity in boys have been weaker (Wang, 2002). Furthermore, studies have found evidence of gender differences in the associations between stressors and child health (Suglia et al., 2012, Amato, 2001).

2.6. 5 Maternal smoking during pregnancy

Maternal smoking during pregnancy will be considered a potential confounder as there is a wealth of literature showing an association between maternal smoking during pregnancy and poorer developmental outcomes in infancy (Wehby et al., 2011, Zheng et al., 2016, Chiolero et al., 2005) and childhood (Knopik, 2009, Gilman et al., 2008b). Maternal smoking during pregnancy is also a strong indicator of socioeconomic disadvantage (Kuntz and Lampert, 2016, Boucher and Konkle, 2016, Gilman et al., 2008a).

There is some evidence of an association between maternal smoking during pregnancy and socioemotional difficulties in childhood, even after adjustment for developmental factors such as premature birth, birth weight and breastfeeding status and

socioeconomic factors including parental education and family income (Melchior et al., 2015).

Maternal smoking during pregnancy has also been shown to predict childhood overweight and obesity in affluent countries (Gorog et al., 2011) with some evidence of a dose-response relationship between the number of cigarettes smoked and weight in childhood, that could not be explained by a wide range of potential confounders (von Kries et al., 2002).

2.6. 6 Diet

Diet is an important determinant of childhood obesity because for obesity to occur energy intake must exceed energy output for a prolonged period of time (Jebb, 2007). However, research has shown very few clear nutrient or food-based determinants of obesity. The strongest evidence for an increased risk of obesity relates to diets that are high in dietary fat or low in fibre (Jebb, 2007, Hu, 2013). However, a substantial limitation in most studies is the reliability of the data on dietary intake, with energy intake often under-reported (World Health Organization, 2003, Livingstone and Black, 2003).

Socioeconomic disadvantage, poor mental health and psychosocial stressors may influence unhealthy food choices (Drewnowski and Specter, 2004, Reidpath et al., 2002). Therefore, diet may mediate the relationship between stressors and obesity, and the relationship between mental health and BMI in children and adolescents. Nonetheless, this thesis does not investigate the potential mediating mechanisms of diet due to the limitations of the data on diet.

2.7 Possible moderators

2.7. 7 Sleep

Family health behaviours may be significant moderators of the associations between childhood stressors, socioemotional difficulties and being obese. In households

characterised by high levels of stressors, family functioning and routines may be negatively affected (Trentacosta et al., 2008). However, higher functioning families may demonstrate greater resiliency to stressors (Sheidow et al., 2014). For example, regular bedtimes may be protective against the harmful effects of stressors on childhood weight gain, as shorter sleep duration has been associated with being overweight and obese (Lumeng et al., 2007, Van Cauter and Knutson, 2008). In addition, studies have found an association between sleep problems and socioemotional difficulties (Beebe, 2011).

In MCS, a dose-response relationship between irregular bedtimes and socioemotional difficulties has been found, as there was a consistent worsening in behavioural scores corresponding to increases in the number of times children did not have regular bedtimes (asked at age 3, 5, and 7 years) (Kelly et al., 2013a). Kelly and colleagues (2013a), observed that children with later bedtimes (9 pm or later) were more likely to be from socially disadvantaged families; with lower incomes, fewer educational qualifications and mothers with poorer mental health. They were also more likely to exhibit unhealthy behaviours, such as skipping breakfast and watching more than three hours of television a day compared to children with earlier bedtimes. In a further study by Kelly and colleagues (2016), not having regular bedtimes associated with being in the 'highest' BMI trajectory (Kelly et al., 2016).

2.7. 8 Physical activity

Many reviews have summarised how regular physical activity can protect against common mental health problems in childhood and adolescence (Biddle and Asare, 2011, Korczak et al., 2017, Toseeb et al., 2014, Janssen and LeBlanc, 2010, Timmons et al., 2012, Ekeland et al., 2004). Physical activity can improve mental well-being through enhancing self-esteem (Tremblay et al., 2000, Ekeland et al., 2004), resilience to stress (Hegberg and Tone, 2015) and improving sleep (Wong et al., 2013). Low levels of physical activity are associated with increased risk of obesity (Pietilainen et

al., 2008, Booth et al., 2012, McManus and Mellecker, 2012). For children living in households characterised by high levels of stressors, regular physical activity could be a protective factor mitigating against the development of socioemotional difficulties and obesity.

2.7. 9 Sedentary behaviour

In addition to the evidence for low physical activity, associations between sedentary behaviours and poorer physical and mental health outcomes have been identified. For children growing up in the new Millennium, television viewing was the most prevalent sedentary behaviour for young people in industrialised countries (Marshall et al., 2006). Electronic screen time entertainment has been associated with socioemotional difficulties, obesity, disrupted sleep and lower cognitive scores in childhood (Mistry et al., 2007, Pagani et al., 2010, Burdette and Whitaker, 2005, Cain and Gradisar, 2010, Heilmann et al., 2017). Various pathways from screen time to children's mental health have been hypothesised. Firstly, it might be that children view material that is not designed for children and is too adult in content (Parkes et al., 2013). It may also be that frequent viewing reduces children's concentration span and increases their inattention (Johnson et al., 2007, Chan and Rabinowitz, 2006), and interferes with time spent in more developmentally appropriate activities (Vandewater et al., 2006). It could also be that frequent television viewing is more common in households with disadvantaged SEP (Shuval et al., 2013, Yang-Huang et al., 2017). However, even after controlling for a number of socioeconomic variables, studies have continued to find longitudinal associations between frequently watching television during childhood and later socioemotional difficulties (Robertson et al., 2013, Landhuis et al., 2007).

The majority of research has been conducted in North America and focused on television. However, using MCS, Parkes and colleagues (2013) used data on television/video/DVD viewing, as well as playing computer and other electronic games. Watching television for more than 3 hours at 5 years predicted a 0.13 (95% CI 0.03 –

0.24) point increase in conduct problems by 7 years, compared to watching for under an hour, but playing computer games was not associated with conduct problems (Parkes et al., 2013). Also, no associations for either type of screen time were found for emotional symptoms, hyperactivity/inattention, peer and relationship problems or prosocial behaviour. They found no gender differences.

Another study using MCS found having a television in the bedroom at age 7 years was associated with significantly higher BMI and fat mass index at age 11 years (Heilmann et al., 2017). These findings are supported by US studies (Gilbert-Diamond et al., 2014, Sisson et al., 2011, Dennison et al., 2002). Heilmann and colleagues (2017) found hours spent watching television was associated with increased risk of overweight among girls only. No associations for computer use and later adiposity were found. The studies in the UK and the US that have found associations between time spent watching television and risk of obesity (Dennison et al., 2002, Griffiths et al., 2011, Hawkins et al., 2009), have often been limited to cross-sectional research so in many cases reverse causality may be argued for.

One explanation for the associations between television viewing and childhood BMI is increased snacking on calorie dense foods while watching television (Coon and Tucker, 2002, Francis and Birch, 2006, Marsh et al., 2014). Another explanation is the exposure to advertisements of calorie dense foods, leading to unhealthy food choices (Coon and Tucker, 2002, Powell et al., 2007, Neville et al., 2005, Lobstein and Dibb, 2005). It has also been argued that as a result of excessive screen time, sleep patterns are disrupted leading to higher BMI (Hale and Guan, 2015, Patel and Hu, 2008, Cespedes et al., 2014). This is primarily through shortened duration and delayed timing of sleep (Cappuccio et al., 2008, Magee et al., 2014). Lastly, a relationship between reduced physical activity and screen time is often hypothesised but this lacks empirical evidence (Pearson et al., 2014, Rey-Lopez et al., 2008, Andersen et al., 1998).

2.7. 10 Family structure

As discussed in earlier sections of this review, there are various family structures found in the UK today with a tendency towards different social, economic and demographic compositions (Panico et al., 2010). Although one of the stressors this thesis focuses on is parental relationship change, family forms themselves may affect the relationship between stressors and children's outcomes. For example, mothers in single-parent families are at greater risk of experiencing depressive symptoms (Hansen and Joshi, 2008, Compas and Williams, 1990), as well as being more likely to experience economic hardship (Panico et al., 2010). However, the evidence on whether single-parent families experience different levels of parent-child conflict to two-parent families is somewhat unclear (Compas and Williams, 1990, Laursen, 2005). For instance, Laursen (2005) found that adolescents reported more total disagreements and angry disagreements with single mothers than adolescents reported with mothers in families with two biological parents. Yet the study found no household structure differences in conflict with parents (mothers and father combined), so the levels of conflict with single mothers are elevated by the same number of disagreements that would otherwise be between adolescents and fathers in two-parent families. Reports of conflict with fathers were no different for families with two biological parents and blended families (Laursen, 2005). The level of conflict may be the same in one or two-parent households, but in two-parent households, parent-child conflict is distributed across two parents, rather than being concentrated to one.

Studies have found that in blended families, children are at greater risk of experiencing adjustment difficulties (Dunn et al., 1998, Dunn, 2002), including adolescent drinking (Kirby, 2006b). However, many of the observed associations are explained by family and maternal characteristics such as maternal age, education, depressive symptoms, history of relationship changes and family financial and housing circumstances (Dunn et al., 1998).

One element of being in a blended family is that children may gain step-siblings. Studies have looked the effects of the number of siblings children have on their adjustment. Siblings play a significant role in children's socioemotional and cognitive development, either as risk factors or as protective factors (Gass et al., 2007, Dai and Heckman, 2013).

Sibling relationships can offer a source of social support for children (Gass et al., 2007). A longitudinal study found sibling affection moderated the relationship between stressful life events and internalising behaviours, regardless of sibling relationship quality. ALSPAC data was used, with stressful life events including accidents, illnesses, legal issues, deaths within the family and permanents separations between parents. Notably, sibling affection did not moderate the effects of stressful life events on externalising behaviours.

In contrast, the resource dilution model hypothesises that as parental resources are finite if the number of children in the family increases, the resources amassed by children will decline. This model posits that siblings are competitors for parents' time, energy and financial resources (Downey, 2001). The literature shows evidence to support the negative effects of large sibship numbers on parental investment in individual children (Lawson and Mace, 2009). Associations between large sibships and child development have mainly been found for children's cognitive performance (Tanskanen et al., 2016, Guo and VanWey, 1999, Kiernan and Mensah, 2009), but if sibship size diminishes family economic resources it may well also affect children's diet and propensity to eat high-calorie food, since those in more disadvantaged economic positions are more likely to consume cheap, energy-dense food (Reidpath et al., 2002). Studies have found that the number of siblings a child has goes some way to explain the association between family stressors and BMI in young children (Stenhammar et al., 2010, Moens et al., 2009). Therefore, family sibship size should be considered as a possible moderating factor for the relationship between stressors and children's mental and physical development.

2.8 Summary

This literature review has drawn on an expansive area of child development research, with the intention of bringing together the different psychosocial stressors children can be exposed to within the home environment into one study. This thesis uses four measures: parental LLI, parental relationship change, family conflict, and maternal depression, to capture psychosocial stressors. This review has provided evidence of the detrimental impacts of these stressors on child health, with regard to increased risk of being obese and having socioemotional difficulties. Prior research has tended to analyse stressors as singular exposures and using cumulative measures but has not analysed the independent effects of multiple stressors, the significance of the time of exposure or the possible moderating effects of family structures and health behaviours. A consistent issue with studies analysing the effects of multiple stressors via a composite measure is that stressors are grouped together regardless of whether stressors may operate differently. Composite methods need to be disentangled to analyse the independent effects of individual psychosocial stressors.

In addition, as studies have found associations between stressors and both socioemotional difficulties and obesity, obesity and socioemotional difficulties may co-occur in households characterised by stress. With the prospect that being obese may exacerbate socioemotional difficulties in children from as young as 3 years via social stigma and subsequent low self-esteem, the relationship between childhood obesity and socioemotional difficulties requires better understanding, accounting for timing and the direction of association.

Understanding inequalities and explanatory factors associated with socioemotional difficulties and obesity in childhood are important when considering long-term effects of health across childhood into adolescence and adulthood (Hinshaw, 1992, Kokko and Pulkkinen, 2000, Goodman et al., 2015, Narusyte et al., 2017, Maffeis and Tato, 2001). By gaining a superior understanding of the pathways which lead to socioemotional

difficulties and obesity in childhood we can identify at-risk children and inform intervention studies and policies to improve population health (Heckman et al., 2006).

Following this evaluation of the existing literature, the next section outlines the aims and objectives of the current study.

Chapter 3: Study Aims and objectives

3.1. Study aim

The aim of this research is to investigate the associations of multiple psychosocial stressors in the home environment with socioemotional difficulties and obesity in the first decade of life.

3.2. Conceptual framework

This research theorises that psychosocial stressors will affect family functioning and the resulting home environment will put children at risk of socioemotional difficulties and obesity. This association is indicated by the large black arrows from stressors to socioemotional difficulties and obesity depicted in Figure 3.1. These associations will be examined cross-sectionally at ages 3, 5, 7 and 11 years and then longitudinally across the first decade of life with a focus on time of exposure and accumulation of risk.

Within the theoretical premise of Bronfenbrenner's ecological systems theory, each stressor is conceptualised as lying within a particular sphere of the environment. This analysis conceptualises limiting longstanding illness and parental relationship change as more distal factors related to children's daily experiences and interactions; and parent-child conflict and maternal mental health as the more proximal factors. Parental relationship change could also be a proximal stressor depending on the family circumstances; for example, if a parent has recently left the household. However, as some parental relationship changes might not directly affect the child's day-to-day life, it is conceptualised as less proximal than parent-child conflict or maternal mental health.

The arrows between obesity and socioemotional difficulties in Figure 3.1 indicate the possible relationship between the two outcomes across time. The small black arrow demonstrates that being obese may exacerbate socioemotional difficulties in children

and this is theorised as the strongest direction of association in the relationship between the two outcomes. As a caveat to that, having socioemotional difficulties may also increase children's risk of becoming obese, which is demonstrated by the grey arrow. However, as children in this study are young and largely reliant on caregivers, children's socioemotional difficulties might not be closely related to their diet and eating behaviours, making this direction of the association between socioemotional difficulties and obesity weak.

An extended conceptual framework, presented in Figure 3.2, demonstrates how stressors may also have their own relationships with one another. Although not examined in this thesis, I hypothesise there are bi-directional associations between parental relationship change, parent-child conflict and maternal mental health and unidirectional associations from parental limiting longstanding illness to other stressors. Parental limiting longstanding illness may increase the risk of families experiencing parental relationship change, parent-child conflict and poor maternal mental health.

3.3. Objective 1

To examine cross-sectional associations between psychosocial stressors in the home environment, socioemotional difficulties and obesity throughout childhood

Hypothesis 1.1: Being exposed to stressors will be associated with greater odds of having high socioemotional difficulty scores and obesity.

3.4. Objective 2

To examine the longitudinal pathways from exposure to psychosocial stressors at repeated time points in childhood to socioemotional difficulties and obesity in pre-adolescence.

Hypothesis 2.1: Exposure to stressors earlier in childhood will be associated with greater odds of having high socioemotional difficulty scores and obesity in pre-adolescence.

Hypothesis 2.2: Compared to experiencing stressors in the past (ages 3, 5, or 7) or present (age 11) only, exposure to stressors at a past time point and again at age 11 years will have a stronger association with socioemotional difficulties and obesity.

3.5. Objective 3

To examine the potential moderating effects of health behaviours on the relationship between stressors in the home environment with socioemotional difficulties and obesity.

Hypothesis 3.1: The associations between stressors and outcomes (socioemotional difficulties and obesity) will be weaker for children who have healthier lifestyles (such as being more physically active, having regular bedtimes and spending less time sedentary).

3.6. Objective 4

To examine the potential moderating effects of family structure on the relationship between stressors in the home environment with socioemotional difficulties and obesity.

Hypothesis 4.1: The association between stressors and outcomes (socioemotional difficulties and obesity) will be weaker for children in two-parent families and for children with fewer siblings.

3.6. Objective 5

To examine the longitudinal pathways between obesity and socioemotional difficulty scores at multiple time points during childhood.

Hypothesis 5.1: Having a higher body mass index earlier in childhood will be associated with having higher socioemotional difficulty scores at older ages.

Hypothesis 5.2: For children experiencing psychosocial stressors, associations between body mass index and socioemotional difficulties will be stronger.

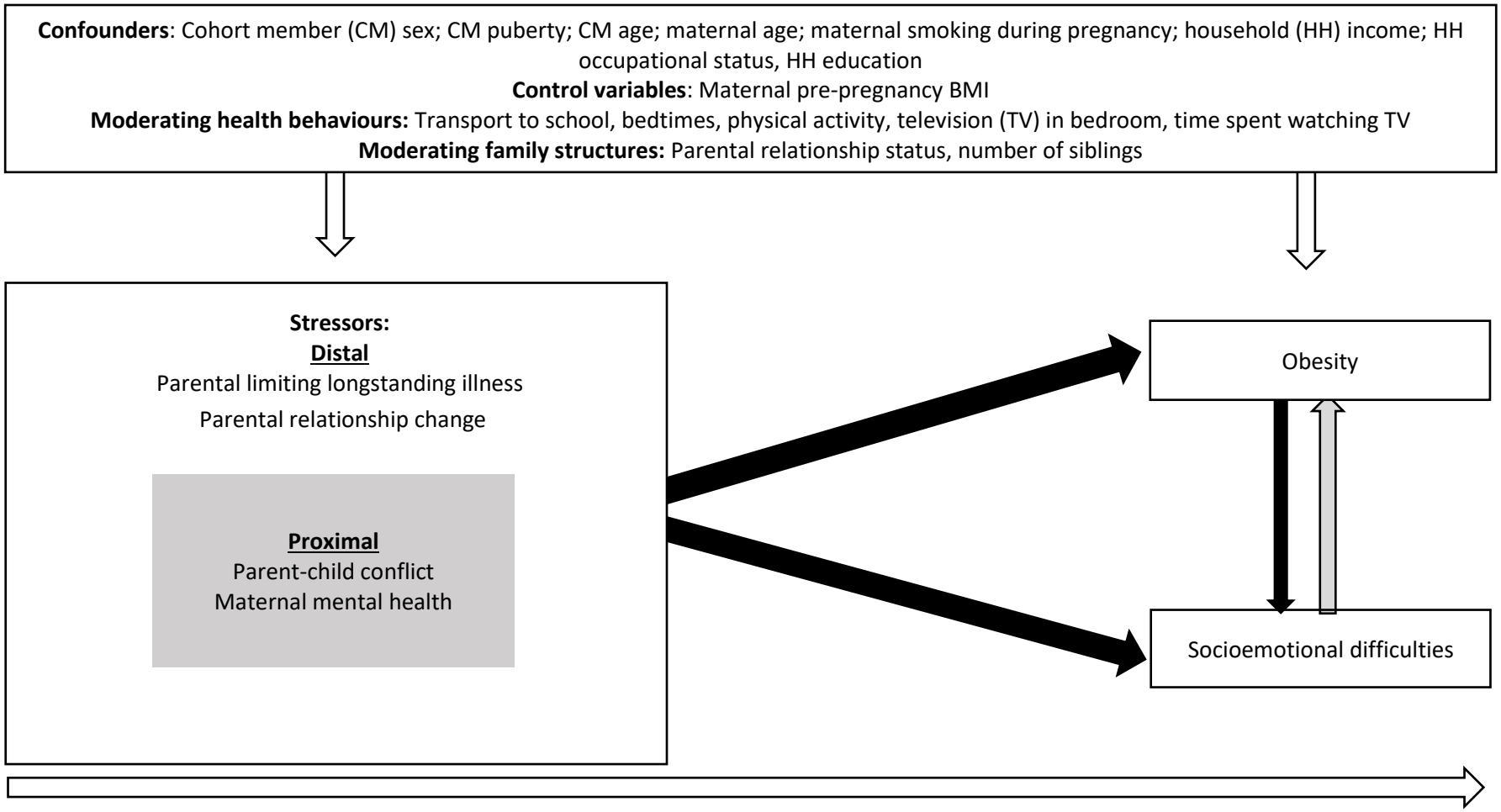

Figure 3. 1 Thesis Conceptual Framework

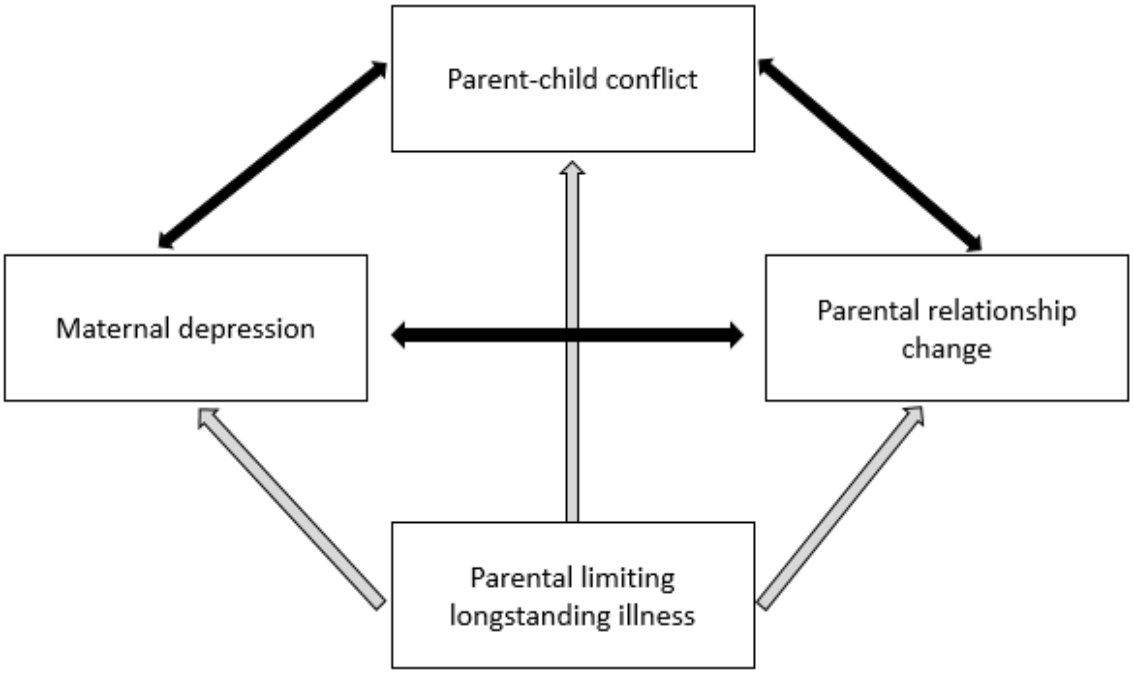

Figure 3.2 Extended conceptual framework showing the relationship between stressors

*Black arrows represent bidirectional associations
** Grey arrows represent unidirectional associations.

Chapter 4: Methods

4.1. Dataset

Established to capture the lives of children in the new century, the MCS sample was drawn from all live births in the UK over 12 months from September 1st in England and Wales and December 1st in Scotland and Northern Ireland in the year 2000 who had survived to 9 months. A random sample of electoral wards was disproportionately stratified to safeguard sufficient representation of all four UK countries, deprived areas and areas with high numbers of Black and Asian families (Centre for Longitudinal Studies, 2014).

The initial sample of 18,552 MCS families yielded 18,818 children with 246 sets of twins and 10 sets of triplets. At sweep two MCS sampled a further 1,389 families who were eligible at sweep one but did not participate then, of these families, 692 were productive. Structured interviews were conducted in the homes of participants who were asked questions about the social, economic, health and demographic features of families' lives. There are 6 sweeps of data available at present. This thesis uses the first five sweeps of data at ages 9 months, 3, 5, 7 and 11 years.

4.1 1 Attrition

MCS has been subject to attrition, with respondents having dropped out of the survey over time (see response rates in Table 5.1). This has led to a reduction in sample size and bias in sample composition (Institute of Education, 2017). Sample bias is due to the likelihood of dropping out being correlated with the socio-demographic characteristics of the respondents. The MCS has lost particular types of respondents, such as disadvantaged families and ethnic minorities, making the sample no longer representative of the UK population (Centre for Longitudinal Studies, 2014). It is likely that families experiencing psychosocial stressors may have dropped out of the MCS, subsequently meaning that the results presented in this thesis might be an under-estimation of the effects of stressors on child health. However, there are statistical

methods to help compensate for this, such as non-response weights (see 4.3. Weighting). The effectiveness of non-response weights to correct for bias is dependent on the inclusion of all important socio-demographic predictors of non-response such as housing tenure and ethnic group (Centre for Longitudinal Studies, 2014).

4.2. Ethical considerations

Ethical approval for the MCS was obtained from the relevant ethics committees at each data collection sweep (Multi-Centre Research Ethics Committee (MREC) and National Health Service Ethical Authority) and parents gave informed consent before interviews (Centre for Longitudinal Studies, 2014).

4.3. Weighting

The design of MCS is such that the data need to be weighted to be representative of any one country (England, Wales, Scotland, and Northern Ireland) or of the UK as a whole. The weights include an adjustment for non-response and the clustered sampling. In the following sections, all sample sizes are unweighted, and all other analyses have had the relevant UK wide weights applied.

4.4. Analytical approach

Complete case analysis was used in chapters 5 and 6, which examine the cross-sectional and longitudinal associations for stressors with socioemotional difficulties and obesity respectively. The distribution of socio-demographic characteristics in the omitted sample compared to the analytical samples were examined in chapters 5 and 6. Understanding the distribution of the data, I chose to examine findings for the existing sample without imputing for missing data. Studies have shown support that complete case analysis and analysis using multiple imputations yield similar results (Mukaka et al., 2016, Groenwold et al., 2012). As with all studies using complete case analysis, it is possible that analysis may underestimate associations (White and Carlin, 2010). However, all complete case analysis uses weights which adjust for non-

response. In chapter 8, sensitivity analyses are performed comparing results of complete case analysis to that for full-information maximum likelihood.

4.5. Respondents

In MCS the adult who completes the questionnaires is referred to as the main respondent. The partner of the main respondent or the second carer in the household is referred to as the partner respondent, and they also complete a questionnaire. Tables 4.1 to 4.4 show, of children who had complete data on outcomes and stressors, who respondents were at each sweep.

4.5. 1 Age 3

For families who had complete data on socioemotional difficulties, obesity and stressors at age 3, Table 4.1 indicates who the MCS respondents were. There were 11,507 main respondents of whom 11,448 were mothers (11,446 biological, and 2 adoptive) and 59 were fathers (all biological fathers). There were 9,711 two-parent families, of whom 9,652 had one mother and one father. Three families had same-sex parents and 56 were another two-parent family form (such as grandparents). There were 1,796 single mothers and no single fathers.

4.5. 2 Age 5

As presented in Table 4.2, at age 5 there were 12,155 main respondents who had complete information on socioemotional difficulties, obesity and stressors. 12,027 were mothers (12,014 biological, 10 adoptive, 1 foster and 2 stepmothers) and 128 were fathers (126 biological, 1 adoptive, 1 stepfather). There were 10,036 two-parent families at age 5, of whom, 9,925 had one mother and one father. There were 5 same-sex parents and 106 were another 2 parent family form. At age 5 there were 2,119 single mothers and no single fathers.

4.5. 3 Age 7

At age 7 there were 11,324 main respondents of whom 11,280 were mothers (11,267 biological, 2 stepmothers and 11 adoptive) and 44 were fathers (43 biological fathers

and 1 stepfather) (see table 4.3). There were 9,053 two-parent families, of whom 8,967 had one mother and one father. Five families had same-sex parents and 81 were another 2 parent family form. There were 2,271 single mothers and no single fathers (see table 4.3).

4.5. 4 Age 11

For children with complete data on outcomes and stressors at age 11, there were 10,119 main respondents of whom 9,955 were mothers (9,942 biological, 1 stepmothers, 3 foster mothers and 9 adoptive), 163 were fathers (158 biological fathers, 1 adoptive and 4 stepfathers) and 1 was a male non relative (see table 4.4). There were 7,998 two-parent families, of whom 7,889 had one mother and one father. Six families had same-sex parents and 103 were another 2 parent family form. There were 2,121 single mothers and no single fathers.

Table 4. 1 Who are the families at age 3 years?

	Partner respondents				
Main respondents	Mother figure	Father figure	Other	No partner	Total
Mother figure	3	9,593	56	1,796	11,448
Father figure	59	0	0	0	59
Other	0	0	0	0	0
Total	62	9,593	56	1,796	11,507

Table 4. 2 Who are the families at age 5 years?

	Partner respondents				
Main respondents	Mother figure	Father figure	Other	No partner	Total
Mother figure	5	9,797	106	2,119	12,027
Father figure	128	0	0	0	128
Other	0	0	0	0	0
Total	133	9,797	106	2,119	12,155

Table 4. 3 Who are the families at age 7 years?

	Partner respondents				
Main respondents	Mother figure	Father figure	Other	No partner	Total
Mother figure	5	8,923	81	2,271	11,280
Father figure	44	0	0	0	44
Other	0	0	0	0	0
Total	49	8,923	81	2,271	11,324

Table 4. 4 Who are the families at age 11 years?

	Partner respondents				
Main respondents	Mother figure	Father figure	Other	No partner	Total
Mother figure	6	7,726	102	2,121	9,955
Father figure	163	0	0	0	163
Other	1	0	0	0	1
Total	170	7,726	66	2,900	10,119

4.6. Outcome measures

There are two outcome measures in this research; obesity and socioemotional difficulties.

4.6. 1 Obesity

During home visits, children's height and weight were measured to calculate BMI. Tanita BF-522W scales were used to measure weight (Centre for Longitudinal Studies, 2014). To take accurate measurements children were asked to remove socks and shoes, and to be wearing only light indoor clothing. Leicester stadiometers were used to measure height (Centre for Longitudinal Studies, 2014). To calculate BMI, weight (in kilograms) was divided by height (in metres) squared (kg/m^2). A derived variable in MCS, using recommended sex and age-specific cut points for BMI defined by the International Obesity Task Force, categorised cohort members as not overweight or obese (including underweight) and overweight or obese (Cole et al., 2000). Categories for children who were a healthy weight or overweight were combined to create a binary variable which was coded as 0 not obese or 1 obese, so as to compare obese children to those who are not.

4.6. 2 Socioemotional difficulties

Socioemotional difficulties were measured via parental report using the Strengths and Difficulties Questionnaire (SDQ) which is a brief behavioural screening questionnaire for children aged between 3 to 17 years (Goodman, 1997). The SDQ consists of 25 items (see psychological inventories in Appendix 4) which are divided equally between 5 subscales: emotional symptoms; conduct problems; hyperactivity/inattention problems; peer and relationship problems; and prosocial behaviour (Goodman, 2001). Each item relating to a behaviour is scored as 0, not true; 1, somewhat true; or 2, certainly true, with reverse coding for positively worded items. Subscales 1 to 4 listed in Table 4.5, can be summed to establish a total difficulties score for each child that ranges from possible scores of 0 to 40.

Table 4. 5 Parent completed Strengths and Difficulties Questionnaire subscales

Subscale	Low	Borderline	High
1 Emotional problems	0-3	4	5-10
2. Conduct problems	0-2	3	4-10
3. Hyperactivity	0-5	6	7-10
4. Peer problems	0-2	3	4-10
5. Prosocial behaviours	6-10	5	0-4

Adapted from Youth in Mind (2015)

To compare children with and without high total difficulties, at each age total difficulties scores were dichotomized at the 90th percentile as 0: <90th percentile low/ borderline, 1: ≥90th percentile high.

Table 4. 6 90th percentile cut points for total difficulties scores at each age

Age	<90th percentile	≥90th percentile
Age 3	0-16	17-40
Age 5	0-13	14-40
Age 7	0-14	15-40
Age 11	0-15	16-40

Goodman, personal communication

Each subscale can be dichotomized by the recommended cut point for problem behaviour as shown in Table 4.5 (Youth in Mind, 2015). Emotional symptoms and peer and relationship problems can be combined to represent symptoms of internalising behaviours. To conduct sensitivity analysis for the types of difficulties children experience at age 11, scores for emotional symptoms and peer and relationship problems were summed and dichotomized at the 90th percentile to create a binary variable of 0, low to borderline scores (scores ≤5) and 1 high score (scores ≥6).

Comparably, conduct problems and hyperactivity can be summed to give a score representing externalising difficulties. Again, scores were dichotomized at the 90th percentile to create a binary variable of 0 low to normal scores (scores ≤7) and 1 high score (scores ≥8).

At ages 7 and 11 years, the Strengths and Difficulties Questionnaire was also administered to children's teachers, to generate teacher-rated socioemotional difficulty scores. This allows comparison between parent and teacher-rated scores, which is discussed in section 4.9.

4.7. Exposure variables

As explained in section 2.4 of the literature review there are multiple areas of stress in children's lives. This thesis focuses on four areas of psychosocial stress in the home environment during childhood which are: parental limiting longstanding illness; parental relationship change; parent-child conflict; and maternal mental health. This study takes one measure to represent each of these areas of stress.

4.7. 1 Parental limiting longstanding illness

Main and partner respondent's health was measured via parental response to the following: "Do you have a longstanding illness, disability or infirmity. By longstanding I mean anything that has troubled you over a period of time or that is likely to affect you over a period of time?" If respondents answered yes they were then asked if the illness limits their activities in any way. Limiting longstanding illness is conceptualised as a distal stressor and dichotomized as either 0, no limiting longstanding illness or 1, yes, one or more parent has a limiting longstanding illness. Parental limiting longstanding illness was not collected at age 3 years (sweep 2), so for analysis at age 3 data collected at sweep 1, age 9 months, was used.

4.7. 2 Parental relationship change

Using the MCS team's derived variable of 'divorce' for analysis would have meant excluding families with parents who had not previously been married. Instead, parental relationship change since the last sweep was used to create parental relationship change at age 3, 5, 7, and 11 years; for example, at age 11 parental relationship change was classified as a change in relationship status from either single, married or cohabiting since age 7. Furthermore, to detect if there had been a change of partner but not a change in relationship status (e.g. cohabiting at both sweeps but with a different person) multiple sweeps of data on whether the biological father was in the household and partner birth date were examined. Responses were dichotomized as 0, stayed the same or 1, changed.

4.7. 3 Parent-child conflict

To capture parent-child conflict at ages 3, 5, and 7 years, main respondents answered items from Straus's Conflict Tactics Scale (Appendix 4) which measures the physical and psychological treatment of children (Straus, 1997). Main respondents were asked how often they did the following when cohort members were naughty: ignore; smack; shout; send to their bedroom or naughty chair; take away treats; tell off, and bribe him or her. The 7 items are scored from 0 "never" to 4 "daily" and summed to create a score ranging from 0 to 28. As presented in the conceptual framework (Figure 3.1) parent-child conflict is conceptualised as a proximate level stressor as it pertains directly to cohort member's behaviour and treatment. The scale was dichotomized at the 90th percentile (Strauss and Knight, 1999, Straus, 2007) to represent those with very high scores (n=1275) compared to those below that.

At age 11 the Conflict Tactics Scale items were not administered to respondents as some items are not as relevant at that age. Instead, a question which asked main respondents whether they have frequent battles with the cohort member was used to measure parent-child conflict. Answers were categorised as 1, yes or 0, no.

4.7. 4 Maternal depression

Maternal mental health was measured via maternal reports on the six-item Kessler Psychological Distress Scale (Appendix 4) which was collected at sweeps 2 to 5 of MCS. Responses to items are scored from 0 "none of the time" to 4 "all of the time" resulting in a total score ranging from 0 to 24. Kessler scores were dichotomized with scores of 13 or more considered to indicate risk of depressive symptoms (Furukawa et al., 2003).

4.8. Covariates

4.8. 1 Maternal characteristics

Biological mother maternal pre-pregnancy body mass index (BMI) was collected at the first sweep of data collection when the cohort member was 9 months old. In MCS

maternal age at birth (in years), collected in sweep 1, is calculated using the cohort member date of birth and the date of birth of the respondent. Maternal smoking status was measured at 9 months by 0: does not smoke and 1: smokes.

4.8. 2 Family socioeconomic characteristics

To maximise cases, all confounders unless sex or parent-specific (such as maternal BMI), are taken from either the main or partner respondent. If data were present for both respondents the highest value was taken; for example, occupational class was obtained at each sweep using the National Statistics Socioeconomic Classification (NS-SEC 5 category version) (Office for National Statistics, 2016) for main and partner respondents based on current or past employment. The most advantaged social class classification in the household was taken to represent the family social class. A sixth category was used to include families where both main and partner respondents had never worked, were students or were long-term unemployed. The six categories, therefore, are 1, managerial and professional; 2, intermediate; 3, small employer/ self-employed; 4, low supervisory and technical; 5, semi-routine and routine; and 6, never worked, student or long-term unemployed.

A categorical variable for highest parental educational qualification in the household was obtained at each sweep comprising: 1, higher degree; 2, first degree/diploma; 3, A/AS levels; 4, GCSE grades A-C; 5, GCSE grades D-G; 6, other/overseas; 7, none.

Family income was captured using a derived MCS variable for income quintiles (weighted for sampling and attrition). More than 1,500 of MCS families, at each data collection sweep, did not provide data on income either by saying they didn't know or refusing to answer (see Appendix 4). Using a number of predictor variables, income data were imputed for missing cases. This was performed by the Centre for Longitudinal Studies using Stata's INTREG command (for a list of predictors see income data in Appendix 4). The Centre for Longitudinal Studies also used OECD

scales for equalisation to account for relative income according to family size (Centre for Longitudinal Studies, 2014).

4.8. 3 Cohort member characteristics

Sex-specific puberty variables were obtained from main respondents, indicating if the children had begun puberty or not. Following previous literature (Goisis et al., 2015), menarche for girls, and voice deepening and facial hair for boys were selected as markers of early puberty at 11 years. Measures were combined to create a gender-neutral puberty status variable consisting of 0 no (has not begun puberty) and 1 yes (has begun puberty).

As exact cohort member (CM) birth and interview dates are not available, the interview month and year, and birth month and year (assuming the 1st of each month for both) were used to create cohort member age (rounded to years) for each sweep.

4.9. Sensitivity analyses

In chapter 5, a series of sensitivity analyses were conducted to examine the differences between paternal and maternal LLI and depression. Using data on who main and partner respondents were, results for paternal and maternal rated LLI in households where measures for both parents exist were compared. Likewise, paternal and maternal rated depression was examined for cross-sectional associations with socioemotional difficulties and obesity at 3, 5, 7, 11 years.

As teacher-rated socioemotional difficulties were measured in addition to parental reports at 7 and 11, a further sensitivity analysis was performed to compare findings for parental and teacher reports for socioemotional difficulties in chapter 5.

Although this thesis is primarily interested in obesity, analyses of cross-sectional and longitudinal associations with stressors, in chapters 5 and 6 respectively, were also conducted using a three-category weight status variable (0, healthy weight, 1, overweight and 2, obesity), to understand associations for obesity. Relative risk ratios were determined using multivariable multinomial logistic regression.

Finally, in chapters 5, 6, and 8, sensitivity analyses were executed to further understand associations for socioemotional difficulties, with analysis repeated for both internalising and externalising subscales.

Output for all sensitivity analyses are discussed throughout empirical chapters and results tables are presented in corresponding appendices.

4.10 Moderators

In chapter 7 the potential moderating effects of health behaviours and family structure on the relationship between stressors in the home environment and socioemotional difficulties and obesity were examined. Health behaviours were captured by measures of physical activity, bedtimes and sedentary activities, such as watching television. Family structure was measured by parent/carer and sibling numbers. Both, health behaviours and family structure measures are explained in the methods section of chapter 7.

The next chapter examines the first stage analysis for this thesis. Cross-sectional logistic regressions were employed to analyse the associations between four family level psychosocial stressors (parental limiting longstanding illness, parental relationship change, parent-child conflict and maternal depression), socioemotional difficulties and obesity at ages 3, 5, 7, and 11 years. First, the analytical sample and analysis strategy are outlined. Then, descriptive and multivariable regression results are presented. Finally, results are discussed with consideration of the existing literature and the strengths and limitations of the analyses.

Following chapter 5, there are a further three empirical analysis chapters. Chapters 6, 7, and 8, examine the longitudinal associations for stressors with socioemotional difficulties and obesity, the potential moderating effects of health behaviours and family structure, and the cross-lagged paths between socioemotional difficulties and BMI across the first decade of life, respectively.

Chapter 5: Cross-sectional analysis of psychosocial stressors, socioemotional difficulties and obesity

Objective 1 of this thesis is to determine whether there are independent cross-sectional associations for psychosocial stressors in the home environment with socioemotional difficulties and obesity throughout childhood. Cross-sectional logistic regressions were conducted at ages, 3, 5, 7 and 11 years. I hypothesise that children who are exposed to stressors will have greater odds of having high socioemotional difficulties and being obese than those who are not exposed. The current chapter describes the analytical sample, the process of analysis, results and discussion for objective 1.

5.1. Analytical sample

At every age, there is a different sample size for each of the socioemotional difficulties and obesity models. This is due to different participation rates at each sweep, different response rates for the study outcomes and because pre-pregnancy BMI was included in the obesity models but not the socioemotional difficulties analyses. Figures 5.1 and 5.2, showing the analytical samples for models at age 11, are presented below to demonstrate how samples were constructed. Analytical sample diagrams for all other models (ages 3, 5 and 7 for socioemotional difficulties and obesity) are presented in Appendix 5 (Figures A5.1 to A5.5). As child behaviour and physiology may differ for multiple births, the analyses include data on singleton-born cohort members only. For models where socioemotional difficulties were the outcome, after excluding multiple births (n=262) there were 11,486 cohort members (CMs) with complete data on stressors, confounders, obesity and socioemotional difficulties at age 3; 11,709 at age 5 years; 10,957 at age 7 years; and 9,229 at age 11 years. Cases with missing data on variables of interest for moderation and sensitivity analysis, such as paternal measures of LLI and Kessler score, teacher-rated socioemotional difficulties, health behaviours and family structures, are removed in later analysis. Obesity model sample sizes were

as follows: 10,752 at age 3 years; 10,930 at age 5 years; 10,226 at age 7 years; and 8,625 at age 11 years. Response rates, final sample sizes and percentages of the cohort that samples represent (approx. 64% to 78%) are as follows in Table 5.1.

Table 5. 1 Achieved sample sizes for MCS sweeps (UK total)

				Final analytical samples			
				Socioemotional difficulties		Obesity	
Sweep	Achieved sample size						
	Families	n	Response rate	n	% of cohort	n	% of cohort
9 months	18,552	18,818	96%	N/A			
3 years	15,590	15,808	81%	11,486	73%	10,752	68%
5 years	15,246	15,459	79%	11,709	76%	10,930	71%
7 years	13,857	14,043	72%	10,957	78%	10,226	73%
11 years	13,287	13,469	69%	9,229	69%	8,625	64%

Adapted from Centre for Longitudinal Studies (2014)

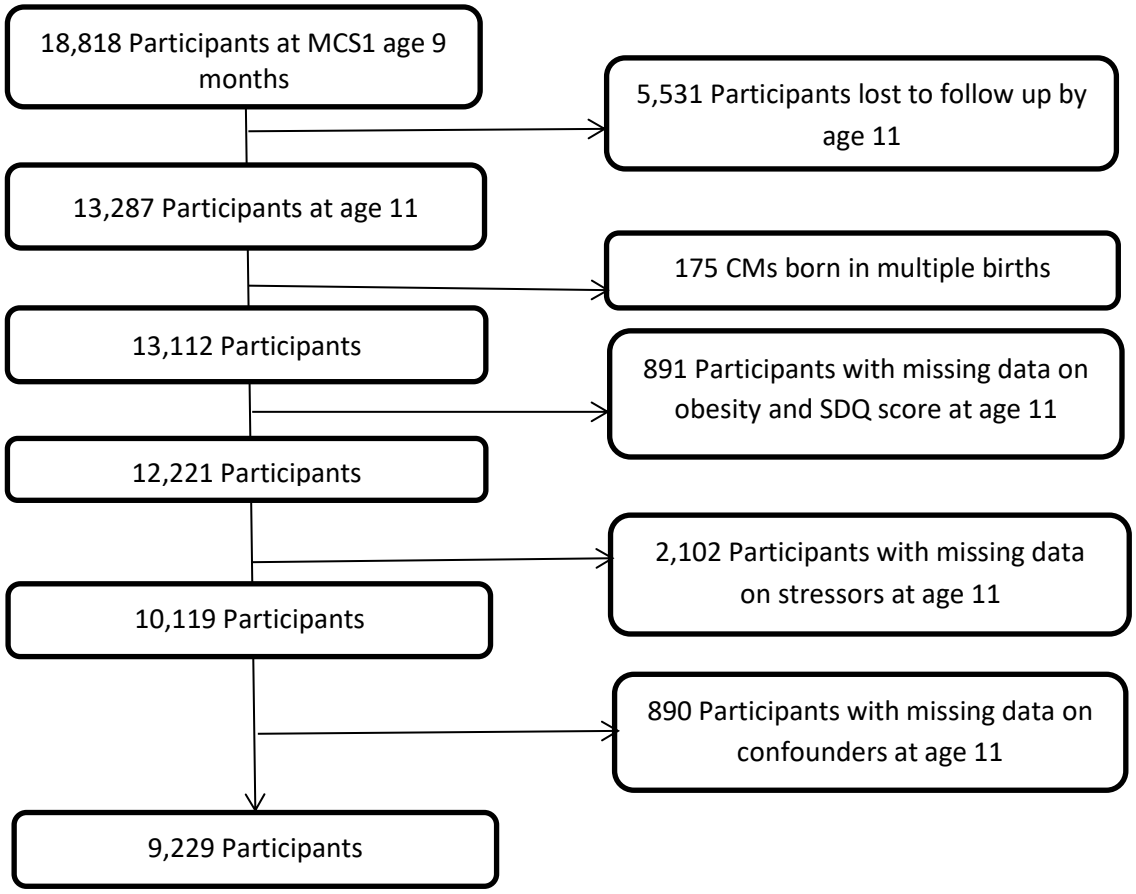

Figure 5. 1 Age 11 socioemotional difficulties analysis sample

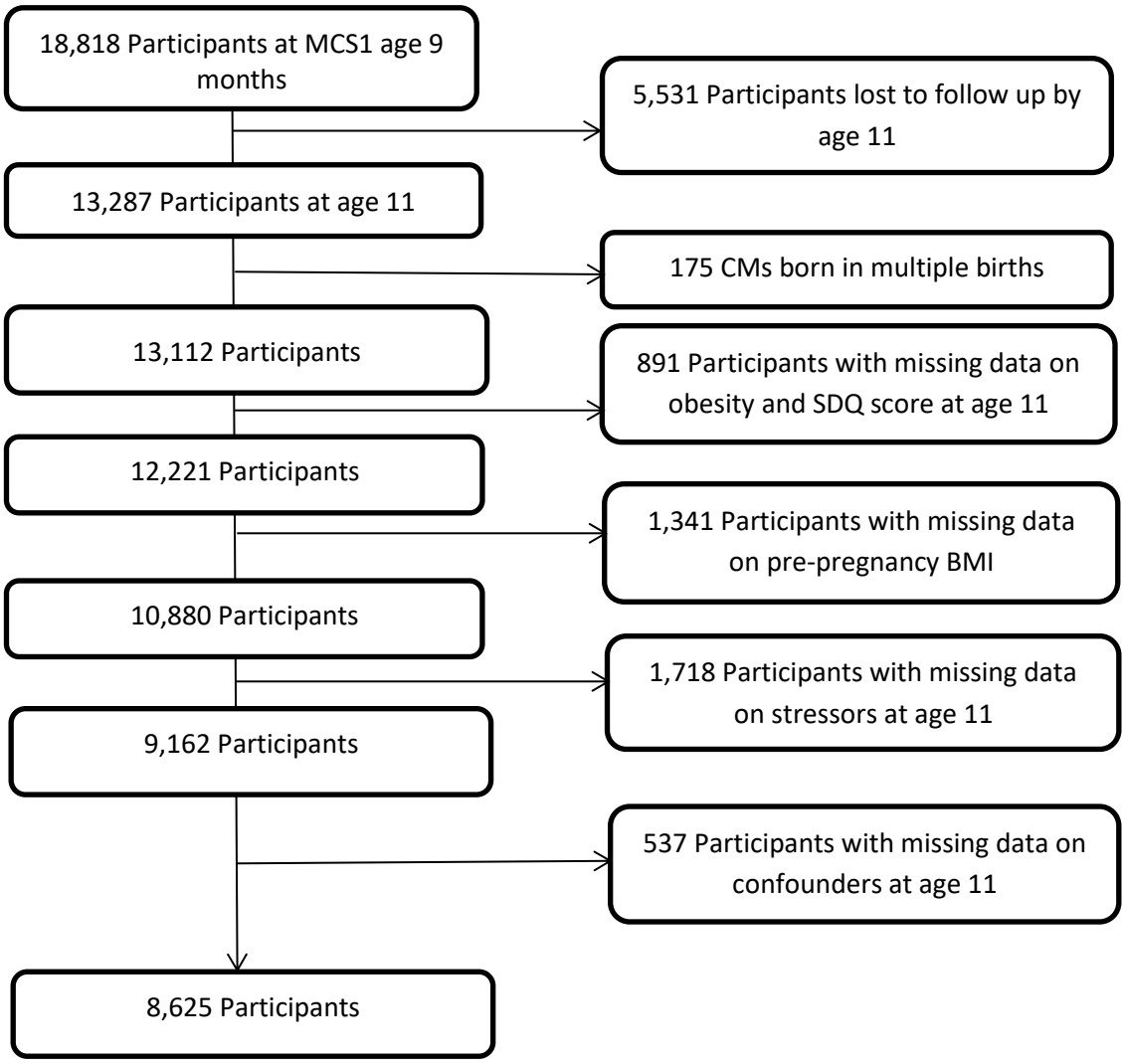

Figure 5. 2 Age 11 obesity analysis sample

5.1. 1 Sensitivity analyses samples

Samples for sensitivity analyses were obtained using the same procedure as outlined above. All final sample sizes for sensitivity analysis are listed below in Table 5.2.

Table 5. 2 Final sample sizes for cross-sectional sensitivity analyses

Sensitivity analyses	Age	Socioemotional difficulties final samples	Obesity final samples
Paternal and maternal LLI	3 years	8,253	7,808
	5 years	8,557	8,031
	7 years	7,431	6,989
	11 years	6,435	6,036
Paternal and maternal depression	3 years	7,892	7,450
	5 years	8,387	7,884
	7 years	7,319	6,891
	11 years	6,257	5,879
Teacher-rated socioemotional difficulties	7 years	7,213	N/A
	11 years	5,229	
Internalising and externalising subscales	3 years	11,486	N/A
	5 years	11,829	
	7 years	11,050	
	11 years	9,246	

5.2. Analytical approach

All statistical analyses were performed in Stata 15 with a significance level of 95% ($p<0.05$). An analysis was performed to assess the distribution of socioemotional difficulties and obesity at ages 3, 5, 7 and 11 years respectively by hypothesised stressors. The distribution of high socioemotional difficulties and obesity at ages 3, 5, 7 and 11 years by potential confounding variables is shown in Appendix 5 (tables A5.1 and A5.2). Likelihood ratio tests showed a significant interaction at age 11 between puberty and sex in the socioemotional difficulties analysis, which means puberty had a different relationship with mental health for boys and girls. To fully account for the sex-specific effects of puberty on the relationship between stressors and socioemotional difficulties, models adjust for the puberty by sex interaction. The puberty by sex interaction is not included in age 11 obesity models because the puberty by sex interaction was not statistically significant in the obesity models. This indicated that there were no sex-specific puberty effects on the relationship between stressors and obesity. Cohort member age was not associated with either outcome or any of the exposure variables, so was not included in the final analysis. Multivariable logistic regressions were used to examine the associations between stressors, socioemotional

difficulties and obesity using the following models of adjustment (In model 2, the puberty by sex interaction is specific to age 11 only).

5.2. 1 Analytical models to examine the associations between psychosocial stressors and socioemotional difficulties, and obesity, at ages 3, 5, 7, 11 years

Model 1: Outcome (socioemotional difficulties or obesity) regressed on stressor (limiting longstanding illness; relationship change; parent-child conflict; or maternal depression)

Model 2: Model 1 + CM and maternal characteristics (CM sex, CM obesity or socioemotional difficulties depending on outcome, CM puberty (obesity model at age 11 only), CM puberty by sex interaction (socioemotional difficulties model at age 11 only), maternal age, maternal pre-pregnancy BMI (obesity models only) and maternal smoking status)

Model 3: Model 2 + family socioeconomic characteristics (income, occupational class and parental education)

Model 4: Model 3 + other stressors (for example, when limiting longstanding illness was entered into model 1 additional stressor variables added in this model were relationship change; parent-child conflict; and maternal depression)

To examine differences in associations depending on who reported measures, the analysis was repeated for paternal reports of depression and separate maternal and paternal reports of LLI in families with two parents. The analysis was also repeated with teacher-rated total socioemotional difficulties at ages 7 and 11 years only, as this is when teacher reports of socioemotional difficulties were collected in addition to parents. Sensitivity analysis was also performed for the socioemotional difficulties subscales of internalising and externalising behaviour.

5.3. Results

5.3. 1 Descriptive results

Descriptive characteristics of the socioemotional difficulties analytical samples at each cross-sectional sweep (age 3, 5, 7, and 11 years) are presented in Table 5.3 Additional descriptives for obesity analytic samples are presented in Appendix 5 (Table A5.3). The distribution of high socioemotional difficulties and obesity by sample characteristics and stressors for age 11 are shown in Table 5.4 (see Appendix 5 for equivalent statistics for all other ages). Throughout the thesis, I will use the term pre-adolescence to describe findings at age 11, although children at age 11 will include some children who have experienced early adolescence. The next section summarises the four sweeps of data in the analysis for objective 1.

5.3. 2 Cohort member characteristics

The sample was equally split between the sexes at each sweep (see table 5.3). At age 11, approximately 13% of children had begun puberty. Because early puberty was determined by different measures for each sex: menarche for girls; voice deepening and facial hair for boys, there were differences in prevalence by sex with 18% of boys and 9% of girls having started puberty. This difference in prevalence may be due in part to the marker for boys early puberty being more sensitive, indicating puberty may have just started. Whereas menarche indicates puberty has definitely begun in girls. Table 5.4 shows that children who had begun puberty had a greater prevalence of high socioemotional difficulties, 13.3% compared to 10.0% for those yet to start puberty, and twice the rate of obesity, 10.0% compared to 5.4% in children who had not begun puberty.

Table 5. 3 Descriptive characteristics of socioemotional difficulties sample (weighted %)

	Age 3 (N=11,486)*	Age 5 (N=11,709)	Age 7 (N=10,957)	Age 11 (N=9,229)
Categorical Variables	%(n)	%(n)	%(n)	%(n)
Outcomes				
Socioemotional difficulties				
Low /Borderline	91.2	91.0	90.4	89.5
High	8.8	9.0	9.6	10.5
Weight Category				
Not obese	94.5	94.8	94.5	93.8
Obese	5.5	5.2	5.5	6.2
Cohort member characteristics				
Sex				
Male	49.8	50.2	50.5	51.1
Female	50.2	49.8	49.5	49.0
Puberty Status				
Not begun	N/A	N/A	N/A	86.5
Has begun				13.5
Maternal smoking status				
Non-smoker	80.0	80.0	80.0	80.0
Smoked	20.0	19.5	20.0	20.0
Socioeconomic characteristics				
Income Quintiles				
Highest quintile	22.2	22.3	22.3	22.7
Fourth quintile	21.7	21.7	21.7	21.6
Third quintile	20.8	21.2	20.4	20.8
Second quintile	18.4	18.5	18.3	19.0
Lowest quintile	16.9	16.3	17.4	15.9
Occupational class				
Managerial /professional	48.3	49.7	48.1	43.9
Intermediate	14.4	13.8	13.6	13.3
Small employers	7.5	8.5	9.5	9.2
Lower supervisory /technical	8.3	7.4	7.3	4.3
Semi-routine /routine	19.4	18.8	19.4	13.3
Unemployed / student	2.1	1.8	2.0	16.0
Education				
NVQ level 5	7.9	10.8	12.6	12.1
NVQ level 4	39.0	38.9	37.3	31.8
NVQ level 3	16.7	16.1	16.0	8.5
NVQ level 2	24.7	23.4	22.8	30.4
NVQ level 1	5.1	4.8	4.6	7.2
Overseas qualification only	1.2	1.4	1.4	2.1
None of these	5.4	4.7	5.3	8.0

5.3. 3 Maternal characteristics

The mean maternal age at birth of the cohort member was 29. Biological mothers had a mean pre-pregnancy body mass index of 24 (kg/m2), which is within the healthy weight range for an adult (World Health Organization, 2017). Twenty per cent of mothers smoked during pregnancy. In households where mothers smoked during pregnancy, there was a greater prevalence of high socioemotional difficulties and the prevalence of obesity was nearly double, compared to households where mothers were non-smokers (see table 5.4).

Table 5. 3 (continued) Descriptive characteristics of socioemotional difficulties samples (weighted %)

	Age 3 (N=11,486)*	Age 5 (N=11,709)	Age 7 (N=10,957)	Age 11 (N=9,229)
Stressors				
Limiting longstanding illness				
No	85.5	80.3	79.6	84.0
Yes	14.5	19.7	20.4	16.0
Parental relationship change				
No	88.8	89.1	93.0	86.2
Yes	11.1	10.9	7.0	13.8
Parent-child conflict				
No	87.1	88.8	89.6	61.7
Yes	12.9	11.2	10.4	38.3
Maternal depression				
No	97.1	97.1	96.6	94.5
Yes	2.9	2.9	3.4	5.5

**LLI at sweep 2 is taken from sweep one (9 months instead of 3 years). Cross-sectional weights applied at each sweep.*

5.3. 4 Family socioeconomic characteristics

The distribution of family NS-SEC class remained stable across the 4 sweeps. Almost half of the samples were in managerial and professional occupations. The next largest classes were intermediate (e.g. clerical and administrative occupations) and semi-routine occupations (e.g. sales and services occupations) (see table 5.3).

At age 3, 8% of the sample was classified as having NVQ level 5 qualifications, such as a postgraduate degree. This increased to 12% across the subsequent sweeps. Between 32% and 39% of the sample was classified as having NVQ level 4 qualifications (e.g. undergraduate degree) across the four sweeps. Sixteen per cent of the sample was categorised with NVQ level 3 qualifications (e.g. AS and A level) at ages 3, 5, and 7 but this dropped to 8% at age 11. Between 23% and 30% of the sample had NVQ level 2 (GCSE grades A*-C). A small proportion of the sample had overseas qualifications (approximately 1%), and between 5% and 8% of the sample at each sweep had no qualifications at all.

There was a greater proportion of high socioemotional difficulties and obesity in households with disadvantaged SEP. For example, at age 11 years children in the highest income quintile had the lowest proportion of high socioemotional difficulties (4.9%) and obesity (3.2%) (Table 5.4). The proportion of both outcomes increased incrementally with a decrease in income quintile, with children in the lowest quintile having the highest prevalence of both outcomes (18.7% for high socioemotional difficulties and 8.7% for obesity). Similar distributions were shown for NS-SEC and education.

Table 5. 4 Prevalence of socioemotional difficulties and obesity by all other variables at age 11 with p-values for Pearson's chi-squared tests for difference

	Socioemotional difficulties %	χ^2 p-value	Obesity %	χ^2 p-value
Cohort member characteristics	(N=9,229)		(N=8,625)	
Total Difficulties				
Low /Borderline	N/A		5.5	35.3
High			10.5	<0.0001
Weight Category				
Not obese	10.0	32.1	N/A	
Obese	17.5	<0.0001		
Sex				
Male	12.9	61.9	5.9	0.1
Female	7.9	<0.0001	6.1	0.7136
Puberty Status				
Not begun	10.0	12.4	5.4	38.3
Has begun	13.3	0.0045	10.0	<0.0001
Maternal smoking status				
Non-smoker	9.2	60.7	5.1	47.5
Smoker	15.4	<0.0001	9.5	<0.0001
Family socioeconomic characteristics				
Income Quintiles				
Highest quintile	4.9		3.2	
Fourth quintile	6.3		4.0	
Third quintile	8.6		6.6	
Second quintile	17.0	297.8	9.0	84.7
Lowest quintile	18.7	<0.0001	8.7	<0.0001
Occupational class				
Managerial and professional	5.7		4.0	
Intermediate	7.5		4.7	
Small employers	10.2		4.6	
Lower supervisory and technical	16.3		9.3	
Semi-routine and routine	13.9	336.5	8.6	109.2
Unemployed, student, never worked	21.7	<0.0001	10.8	<0.0001
Education				
NVQ level 5	5.1		2.6	
NVQ level 4	6.9		4.4	
NVQ level 3	9.3		4.7	
NVQ level 2	12.1		6.8	
NVQ level 1	17.2		8.4	
Overseas qualification only	12.0	214.1	9.9	108.1
None of these	21.6	<0.0001	13.1	<0.0001

**Cross-sectional weights applied at each sweep.*

5.3. 5 Stressors

From 14-20% of the sample had a parent with a limiting longstanding illness (LLI) at each sweep. Table 5.5 shows the distribution of high socioemotional difficulties by exposure to stressors. At every sweep, parental LLI was associated with a greater proportion of high socioemotional difficulties, with the largest proportions in pre-adolescence (18.5% at age 11). Table 5.6 shows that the prevalence of obesity was higher for children whose parents had a LLI than for those with parents in better health.

Eleven per cent of the sample had been exposed to a parental relationship change between ages 9 months and 3 years and between 3 and 5 years. This dropped to 7% between ages 5 and 7 years and then increased to just under 14% by 11 years. In households where parents had been through a relationship change, there were greater proportions of high socioemotional difficulties in children, but only small differences in proportions of obesity were found.

Thirteen per cent of the sample experienced high parent-child conflict at age 3 years, this fell slightly in middle childhood (only 11% with high parent-child conflict at ages 5 and 10% at 7 years) and became more prevalent again in pre-adolescence, with 38% of 11-year-olds having frequent battles with parents. The higher rates of conflict at age 11 may be due in part to use of a different measure (see chapter 4). At all ages there were much higher rates of high socioemotional difficulties for children who had experienced high conflict at each age, for example at age 11, 21% of children who had frequent battles with parents had high socioemotional difficulties compared to 3.9% of children who did not have frequent battles with parents.

The proportion of mothers with depressive symptoms was comparably smaller than that for the other three stressors and remained at a stable 3% across ages 3, 5, and 7. The proportion of mothers with depressive symptoms rose to 5% at age 11 (see table 5.3). There were substantially larger proportions of high socioemotional difficulties for children exposed to maternal depression, for example, 35.2% compared to 9% for unexposed children at age 11 (table 5.4).

5.3. 6 Outcomes

The proportion of high socioemotional difficulties was around 9-10% at all ages (Table 5.4). The rate of high socioemotional difficulties increased with age, for example, there were 9.6% of children with high socioemotional difficulties at age 7 and 10.5% at age 11. The proportion of high socioemotional difficulties in children who were obese (17.5%), was 7% higher than that of children who were not obese (10.0%); showing that children who were obese were also more likely to be experiencing more difficulties with behaviour and relationships compared to their peers. Similar to obese children having a greater proportion of high socioemotional difficulties than non-obese children, children with high socioemotional difficulties at age 11 years had a greater rate of obesity (10.5%), compared to children who did not have high socioemotional difficulties (5.5%).

Table 5. 5 Distribution of socioemotional difficulties by stressors with p-values for Pearson's chi-squared tests for difference

	Age 3 (N=11,486)		Age 5 (N=11,709)		Age 7 (N=10,957)		Age 11 (N=9,229)	
	%	χ^2 p-value	%	χ^2 p-value	%	χ^2 p-value	%	χ^2 p-value
Stressors								
Limiting longstanding illness								
No	8.2	33.4	8.1	47.7	8.4	62.7	8.9	120.6
Yes	12.5	<0.0001	12.7	<0.0001	13.9	<0.0001	18.5	<0.0001
Parental relationship change								
No	8.1	59.8	8.1	91.7	9.2	15.9	9.8	26.5
Yes	14.6	<0.0001	16.2	<0.0001	13.7	0.0004	14.6	<0.0001
Parent-child conflict								
No	7.2	251.7	6.8	553.3	7.3	529.1	3.9	676.0
Yes	19.7	<0.0001	26.5	<0.0001	28.5	<0.0001	21.0	<0.0001
Maternal depression								
No	8.1	240.6	8.1	354.5	8.7	292.8	9.0	351.6
Yes	32.7	<0.0001	37.7	<0.0001	35.3	<0.0001	35.2	<0.0001

**Cross-sectional weights applied at each sweep.*

The proportion of high socioemotional difficulties in children was higher when they were exposed to stressors, most markedly for children whose mothers had depressive symptoms (see table 5.5). The proportion of childhood obesity was 5% at ages 3, 5 and 7 years, and then was higher at age 11 years (6.2%). At all ages, the rate of obesity was slightly higher amongst children who were exposed to stressors (approximately 1-2% higher, see table 5.6), again most markedly for children whose mothers reported depressive symptoms at age 11. Of the children whose mothers reported depressive symptoms at age 11, 14% were obese, compared to 5.5% for others without mothers with depressive symptoms.

Table 5. 6 Distribution of obesity by stressors with p-values for Pearson's chi-squared tests for difference

	Age 3 (N=10,752)		Age 5 (N=10,930)		Age 7 (N=10,226)		Age 11 (N=8,625)	
	%	χ^2 p-value	%	χ^2 p-value	%	χ^2 p-value	%	χ^2 p-value
Stressors								
Limiting longstanding illness								
No	5.3	1.2	5.0	5.5	4.9	9.1	5.6	9.5
Yes	4.7	0.3734	6.2	0.0402	6.6	0.0156	7.8	0.0132
Parental relationship change								
No	5.2	0.4	5.1	2.4	5.2	0.2	5.8	2.4
Yes	5.6	0.5964	6.1	0.1761	5.7	0.6596	7.0	0.1870
Parent-child conflict								
No	5.2	0.3	4.9	3.8	5.3	0.2	5.8	1.2
Yes	5.6	0.6381	6.3	0.1015	5.0	0.6442	6.3	0.3328
Maternal depression								
No	5.2	0.1	5.2	0.3	5.2	2.2	5.5	58.3
Yes	4.8	0.7712	4.5	0.5847	7.1	0.1849	14.3	<0.0001

**Cross-sectional weights applied at each sweep.*

5.3. 7 Missing data

As the eligible longitudinal MCS sample was reduced due to missing data on all covariates except for sex and income, which had complete data, an analysis was conducted to examine if the distribution of outcomes by all other variables differed in the omitted sample compared to the analysis samples. Table 5.7 presents the prevalence of socioemotional difficulties and obesity at 11 years in omitted sample and analysis sample by all available data on confounders and stressors. Children who were

not included in the analytical sample were more likely to have socioemotional difficulties, but the prevalence of obesity was relatively similar across samples.

Table 5. 7 Prevalence (%) of socioemotional difficulties and obesity at 11 years in omitted sample and analysis sample by all available data on confounders and stressors

	Socioemotional difficulties %		Obesity %	
Cohort member characteristics	Omitted from sample (N=3,883)	Analytical sample (N=9,229)	Omitted from sample (N=4,487)	Analytical sample (N=8,625)
Total Difficulties				
Low /Borderline	N/A		6.5	5.5
High			11.0	10.5
Weight Category				
Not obese	16.3	10	N/A	
Obese	27.7	17.5		
Sex				
Male	19.9	12.9	6.9	5.9
Female	14.4	7.9	7.6	6.1
Puberty Status				
Not begun	18.2	10.0	5.8	5.4
Has begun	20.1	13.3	9.7	10.0
Maternal smoking status				
Non-smoker	17.0	9.2	7.3	5.1
Smoker	19.0	15.4	7.7	9.5
Family socioeconomic characteristics				
Income Quintiles				
Highest quintile	3.6	4.3	2.9	3.1
Fourth quintile	7.4	7.5	4.8	4.0
Third quintile	11.5	8.9	6.3	6.6
Second quintile	22.3	14.7	10.0	9.0
Lowest quintile	23.9	18.0	7.9	8.7
Occupational class				
Managerial and professional	8.1	6.5	4.8	4.0
Intermediate	9.6	10.6	5.8	4.7
Small employers	14.3	9.6	8.9	4.6
Lower supervisory and technical	19.8	14.2	8.6	9.3
Semi-routine and routine	24.2	16.3	9.4	8.6
Unemployed, student, never worked	25.7	25.6	8.0	10.8
Education				
NVQ level 5	1.1	4.3	3.9	2.6
NVQ level 4	9.0	6.8	4.5	4.4
NVQ level 3	13.4	10.5	6.6	4.7
NVQ level 2	18.6	13.4	8.3	6.8
NVQ level 1	26.7	15.6	11.1	8.4
Overseas qualification only	23.1	14.5	7.5	9.9
None of these	26.0	21.5	7.9	13.1

Table 5. 7 (continued) Prevalence (%) of socioemotional difficulties and obesity at 11 years in analyses sample and omitted sample by confounders and stressors

	High socioemotional difficulties %		Obesity %	
Stressors	Omitted from sample (N=3,883)	Analytical sample (N=9,229)	Omitted from sample (N=4,487)	Analytical sample (N=8,625)
Limiting longstanding illness				
No	14.4	8.9	6.5	5.6
Yes	29.2	18.5	10.1	7.8
Parental relationship change				
No	14.2	9.8	7.0	5.8
Yes	19.9	14.6	7.5	7.0
Parent-child conflict				
No	6.6	3.9	6.6	5.8
Yes	33.9	21.0	8.4	6.3
Maternal depression				
No	14.5	9.0	7.1	5.5
Yes	47.7	35.2	13.1	14.3

5.4 Multivariable regression results

Socioemotional difficulties analysis

5.4. 1 Limiting longstanding illness (LLI)

At age 3, children who had a parent with a LLI had 61% greater odds of having high socioemotional difficulties in the unadjusted model than those who did not. Associations between LLI and socioemotional difficulties were larger at older ages, with the unadjusted odds of high socioemotional difficulties over two times higher for children whose parent had a LLI at age 11, than for those who did not (see table 5.8).

Table 5. 8 Odds ratios (95% CI) for multivariable logistic regression models showing the conditional association between parental limiting longstanding illness and socioemotional difficulties

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=11,486)				
No	Reference category			
Yes	1.61***	1.61***	1.38***	1.22*
	1.34 - 1.93	1.34 - 1.93	1.15 - 1.65	1.00 - 1.49
Age 5 (N=11,709)				
No	Reference category			
Yes	1.65***	1.65***	1.46***	1.30**
	1.40 - 1.95	1.39 - 1.96	1.22 - 1.75	1.07 - 1.58
Age 7 (N=10,957)				
No	Reference category			
	1.76***	1.79***	1.64***	1.46***
Yes	1.48 - 2.09	1.51 - 2.13	1.37 - 1.96	1.21 - 1.75
Age 11 (N=9,229)				
No	Reference category			
Yes	2.31***	2.25***	1.90***	1.54***
	1.91 - 2.80	1.84 - 2.76	1.54 - 2.35	1.21 – 1.96

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Associations were largely unaffected by the addition of cohort member and maternal characteristics in Model 2. In Model 3, family socioeconomic factors were introduced into the analysis, which led to a reduction in adjusted odds ratio (aOR) effect sizes, with income and NS-SEC mainly attenuating associations. In Model 4, after final adjustment

for other stressors (relationship change, parent-child conflict and maternal depression), parental LLI remained significantly associated with having higher socioemotional difficulties at every age.

Externalising and internalising difficulties

Associations between LLI and both socioemotional difficulty subscales were weaker than for total socioemotional difficulties. At age 11, exposure to LLI had a stronger association with high internalising behaviours than externalising behaviours. For example, children aged 11 who were exposed to parental LLI had 42% higher odds of experiencing emotional or peer and relationship problems and 30% higher odds of conduct, hyperactivity and/or inattention problems compared to children who were not exposed to parental LLI. However, as confidence intervals for externalising and internalising estimates overlap there is no significant difference between the two (see Appendix 5, Tables A5.4 and A5.8).

Analyses of maternal and paternal reported LLI

Sensitivity analyses were used to examine whether there were differences in associations for maternal and paternal reported LLI in households where there were measures for both parents. At age 11, there were 670 mothers and 520 fathers who had a LLI. In unadjusted models, paternal LLI was associated with 45-69% greater odds of high socioemotional difficulties at ages 3, 5, and 7. At age 11, children exposed to paternal LLI had twice the odds of having high socioemotional difficulties, compared to children who were not exposed. Adjustment for child and maternal characteristics made very little difference to odds ratios, but after the addition of measures of family SEP into the model, associations were fully attenuated at age 3, 5, and 7 years. The association at age 11 remained robust to full adjustment at age 11, with exposed children 50% more likely to have high socioemotional difficulties compared to other children (aOR 1.50, 95% CI 1.03-2.19). Odds ratios for maternal LLI were very similar in size to those in the parental LLI analysis (see Appendix 5, Tables A5.12 and A5.13).

Teacher-rated socioemotional difficulties

Teacher-rated socioemotional difficulties were available at age 7 and 11 years. Sensitivity analyses were conducted to examine the differences in associations between stressors and socioemotional difficulties for teacher-rated socioemotional difficulties and parent-rated socioemotional difficulties. Compared with the analysis of parent-rated socioemotional difficulties, there were weaker associations for parental LLI and teacher-rated socioemotional difficulties. At age 7 there was no association between parental LLI and teacher-reported socioemotional difficulties in any model. In unadjusted models at age 11 years, children who were exposed to parental LLI had 60% higher odds of having high teacher-rated socioemotional difficulties. The association stayed much the same after adjustment for child and maternal characteristics. However, unlike the association between parental LLI and parent report socioemotional difficulties, which remained significant for every age and in every model, after adjustment for family SEP measures the association for teacher-reported socioemotional difficulties was fully attenuated (Appendix 5, table A5.17).

5.4. 2 Relationship change

Unadjusted models at all ages show parental relationship change was associated with greater odds of high socioemotional difficulties. The unadjusted magnitude of associations varies by age, with the largest association at age 5 (OR 2.19, 95% CI 1.81-2.66) (see table 5.9). In Model 2, after adjusting for cohort member and maternal characteristics, odds ratios were partially attenuated, but odds of high socioemotional difficulties continued to be significantly higher for children exposed to relationship change for ages 3, 5 and 11 years. Adding family socioeconomic factors into the analysis reduced associations, with only estimates at age 5 remaining significant (OR 1.45, 95% CI 1.19-1.77).

In the final model, after adding the remaining stressor variables to the model (LLI, parent-child conflict, and maternal depression), the estimate for age 5 was attenuated

further but remained significant, with children exposed to parental relationship change from age 3 to 5 years having 32% greater odds of high socioemotional difficulties at age 5 years.

Table 5. 9 Odds ratios (95% CI) for multivariable logistic regression models showing the conditional association between relationship change and socioemotional difficulties

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=11,486)				
No	Reference category			
Yes	1.94***	1.24*	0.90	0.88
	1.60 - 2.36	1.00 - 1.53	0.73 - 1.11	0.71 - 1.10
Age 5 (N=11,709)				
No	Reference category			
Yes	2.19***	1.76***	1.45***	1.32**
	1.81 - 2.66	1.45 - 2.13	1.19 - 1.77	1.08 - 1.61
Age 7 (N=10,957)				
No	Reference category			
	1.55***	1.22	0.89	0.88
Yes	1.22 - 1.98	0.95 - 1.56	0.68 - 1.16	0.65 - 1.19
Age 11 (N=9,229)				
No	Reference category			
Yes	1.57***	1.29*	1.12	1.23
	1.26 - 1.95	1.02 - 1.64	0.88 - 1.43	0.95 - 1.60

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on relationship change
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Externalising and internalising difficulties

There were no marked differences between analyses of relationship change for subscales compared to for total socioemotional difficulties analysis (see Appendix 5, tables A5.5 and A5.9).

Teacher-rated socioemotional difficulties

Parental relationship change and teacher-rated socioemotional difficulties were only significantly associated at age 7 in the unadjusted model. After adjustment for child and maternal characteristics, the association was fully attenuated. There were no associations between relationship change and teacher-rated socioemotional difficulties at age 11 years (Appendix 5, Table A5.16).

5.4. 3 Parent-child conflict

At every age, in unadjusted models, parent-child conflict was associated with between 3 and 6 times the odds of having high socioemotional difficulties (e.g. OR 6.47, 95% CI 5.30 - 7.90 at age 11 years, see table 5.10). The size of associations rose with age.

Table 5. 10 Odds ratios (95% CI) for multivariable logistic regression models showing the conditional association between parent-child conflict and socioemotional difficulties

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=11,486)				
No	Reference category			
Yes	3.16***	2.86***	3.11***	2.98***
	2.67 - 3.74	2.40 - 3.40	2.59 - 3.73	2.47 - 3.60
Age 5 (N=11,709)				
No	Reference category			
Yes	4.95***	4.49***	5.26***	4.94***
	4.20 - 5.83	3.80 - 5.30	4.41 - 6.27	4.12 - 5.92
Age 7 (N=10,957)				
No	Reference category			
	5.02***	4.44***	4.59***	4.37***
Yes	4.27 - 5.91	3.73 - 5.28	3.82 - 5.52	3.61 - 5.30
Age 11 (N=9,229)				
No	Reference category			
Yes	6.47***	6.29***	6.90***	6.65***
	5.30 - 7.90	5.14 - 7.70	5.60 - 8.51	5.37 - 8.25

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on parent-child conflict
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

At age 3, children with parent-child conflict were around 2-3 times more likely to have socioemotional difficulties (OR 2.56, 95% CI 2.22 – 2.95). Associations between parent-child conflict and socioemotional difficulties were larger at ages 5 and 7 years, with exposed children around 5 times more likely to have socioemotional difficulties compared to children who were not experiencing parent-child conflict. By age 11, children who had frequent battles with parents were around 6 times more likely to have socioemotional difficulties (although confidence intervals for ages 5 and 11 years did overlap).

Estimates in Models 2, 3 and 4 show hypothesised confounding factors attenuated very little of the associations. At every age, estimate confidence intervals for Models 1 and 4 overlap showing there is no real difference in odds ratios after adjustment.

Externalising and internalising difficulties

Subscale analyses showed that for children who experienced parent-child conflict, the difficulties they might experience are more likely to be expressed as externalising behaviours compared to internalising. Odds ratios for externalising behaviours were a similar magnitude to estimates for total socioemotional difficulties (see Appendix 5, Table A5.6). Children who experienced parent-child conflict were also more likely to have internalising difficulties, although to a lesser extent than externalising difficulties, for example children exposed to conflict at age 11 were 2.6 times more likely to have internalising difficulties (see Appendix 5, table A5.10) compared to having a 6 fold increase in odds of externalising difficulties.

Teacher-rated socioemotional difficulties

At ages 7 and 11 years, in every model of adjustment, exposure to high parent-child conflict was associated with 2-3 times greater odds of high teacher-rated socioemotional difficulties. Adjustment for confounding factors had very little effect on model estimates (Appendix 5, table A5.18).

5.4. 4 Maternal depression

In unadjusted models, exposure to maternal depression was consistently associated with over 5 times the odds of having high socioemotional difficulties for children at each age. In model 2, which controlled for cohort member and maternal characteristics, odds ratios were reduced but estimates for high socioemotional difficulties remained around 5 times higher for children exposed to maternal depression at every age. In model 3, after additionally adjusting for family SEP, children exposed to maternal depression

were approximately 3-4 times more likely to have high socioemotional difficulties than others.

Table 5. 11 Odds ratios (95% CI) for multivariable logistic regression models showing the conditional association between maternal depression and socioemotional difficulties

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=11,486)				
No	Reference category			
Yes	5.49***	4.75***	3.53***	3.11***
	4.18 - 7.19	3.58 - 6.31	2.61 - 4.79	2.26 - 4.28
Age 5 (N=11,709)				
No	Reference category			
Yes	6.81***	5.97***	4.21***	3.28***
	5.35 - 8.67	4.59 - 7.76	3.20 - 5.53	2.44 - 4.42
Age 7 (N=10,957)				
No	Reference category			
	5.76***	4.85***	3.59***	2.86***
Yes	4.31 - 7.69	3.62 - 6.51	2.65 - 4.88	2.08 - 3.94
Age 11 (N=9,229)				
No	Reference category			
Yes	5.48***	5.03***	3.68***	2.85***
	4.19 - 7.18	3.85 - 6.57	2.76 - 4.92	2.07 - 3.93

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on maternal depression
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

In fully adjusted models, children exposed to maternal depression had around three times greater odds of experiencing high socioemotional difficulties. Log-transformed odds ratios at age 11 show that from Model 1 to Model 4 there was approximately a 38% reduction in log odds of high socioemotional difficulties after exposure to maternal depressive symptoms, with most of the attenuation explained by socioeconomic measures and other stressors (LLI, relationship change and parent-child conflict). Age of exposure had little effect on the strength of the cross-sectional association between maternal depression and children's socioemotional difficulties between the ages of 3 and 11 years (see table 5.11).

Externalising and internalising difficulties

There were no marked differences in effect estimates between analyses of maternal depression for subscales than for the total socioemotional difficulties analysis (see Appendix 5, tables A5.7 and A5.11).

For maternal depression, the effects of additional adjustment for opposite subscales were explored. At each age, after additional adjustment for internalising difficulties, associations for maternal depression and externalising difficulties were attenuated further, but all associations remained statistically significant (e.g. age 11 OR 1.52, 95% CI 1.12-2.08, compared to OR 2.13, 95% CI 1.62-2.80). Similarly, additional adjustment for externalising difficulties partially attenuated the association between maternal depression and internalising difficulties at each age (e.g. age 11 OR 2.65, 95% CI 1.89-1.64, compared to OR 3.00, 95% CI 2.21-4.07, see Appendix 5, tables A5.7 and A5.11).

Analysis of maternal and paternal reported depression

Sensitivity analyses were used to examine whether there were differences in associations for maternal and paternal reported depression in households that had data for both parents. Prevalence of depression was similar for each sex. For example, at age 11, 207 mothers and 217 fathers had depressive symptoms. Paternal depression was associated with increased odds of socioemotional difficulties but associations were weaker than for maternal depression. For maternal depression there were strong associations with behaviour for all ages in models of adjustment, however, in final models for paternal depression, only associations for ages 3 and 7 years were robust to full adjustment, indicating between a 78% to 100% increase in odds of high socioemotional difficulties ($P<0.05$) for children exposed than for others (see Appendix 5 tables A5.14 and A5.15).

Teacher-rated socioemotional difficulties

At age 7 in unadjusted models, maternal depression was associated with a threefold increase in odds of high teacher-rated socioemotional difficulties. Each level of adjustment attenuated the association somewhat, with the odds ratio of having high teacher-rated socioemotional difficulties in the final model just under two times greater for children exposed to maternal depression compared with children who were not exposed (Appendix 5, table A5.19). At age 11, the unadjusted odds ratio was 2.84 (95% CI 1.78-4.53). Adjustment for child and maternal characteristics partially attenuated the association (aOR 2.56, 95% CI 1.62-4.04) and adjustment for family SEP further reduced the association (aOR 1.66, 95% CI 1.04-2.64). In the final model, which included all other stressors (LLI, relationship change and parent-child conflict), the association was fully attenuated.

5.4. 5 Summary of socioemotional difficulties analysis

Looking at associations between stressors and socioemotional difficulties by age, for parent-child conflict, the largest associations with behaviour were seen at age 11. After final adjustment for other stressors (parental LLI, parent-child conflict and maternal depression), relationship change was only associated with socioemotional difficulties at age 5. Children whose mothers reported depressive symptoms had three times the odds of having socioemotional difficulties at each age.

The largest associations between stressors and socioemotional difficulties were for parent-child conflict at every age, followed by maternal depression. Both stressors were consistently associated with socioemotional difficulties at every level of adjustment. The strongest association for parent-child conflict and socioemotional difficulties was at age 11: children experiencing this type of psychosocial stressor had an almost seven-fold increase in odds of having high socioemotional difficulties, compared to children who were not exposed to high parent-child conflict, independent of all other stressors.

Obesity analysis

5.4. 6 Limiting longstanding illness (LLI)

At ages 5, 7 and 11 years, children with a parent with a LLI had greater odds of being obese than children who did not have a parent with a LLI (see table 5.12). There was no association between LLI and obesity at age 3 in any model. Unadjusted associations were significant at every other age and confidence intervals widened incrementally with age. After controlling for maternal characteristics (maternal age, pre-pregnancy BMI and smoking status during pregnancy) estimates failed to reach significance, with associations largely attenuated by adjustment for maternal pre-pregnancy BMI.

Overweight

A similar pattern of results was observed for sensitivity analyses of overweight children, with exposure to parental LLI associated with greater odds of being overweight at 7 and 11 years in the unadjusted analysis only (see Table A5.24 in Appendix 5).

Table 5. 12 Odds ratios (95% CI) for multivariable logistic regression models showing the conditional association between parental limiting longstanding illness and obesity

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=10,752)				
No	Reference category			
Yes	0.87	0.76	0.71*	0.73
	0.63 - 1.19	0.55 - 1.05	0.51 – 1.00	0.52 - 1.02
Age 5 (N=10,930)				
No	Reference category			
Yes	1.28*	1.12	1.10	1.12
	1.01 - 1.61	0.89 - 1.43	0.86 - 1.40	0.88 - 1.43
Age 7 (N=10,226)				
No	Reference category			
	1.36*	1.15	1.09	1.09
Yes	1.06 - 1.75	0.89 - 1.50	0.84 - 1.42	0.84 - 1.42
Age 11 (N=8,625)				
No	Reference category			
Yes	1.42*	1.11	0.91	0.85
	1.07 - 1.87	0.81 - 1.51	0.66 - 1.26	0.61 - 1.19

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Obesity regressed on parental limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Analysis of maternal and paternal reported LLI

A separate analysis of LLI for mothers and fathers showed that only paternal LLI was associated with childhood obesity. However, whilst paternal LLI was associated with 60-80% greater odds of obesity at ages 7 and 11 years in unadjusted models, after adjustment for child and maternal characteristics and family SEP all associations were fully attenuated (see Appendix 5, tables A5.20 and A5.21).

5.4. 7 Relationship change and parent-child conflict

Parental relationship change and parent-child conflict were not associated with children's obesity at any age, in any of the models (tables 5.13 and 5.14).

Table 5. 13 Odds ratios (95% CI) for multivariable logistic regression models showing the conditional association between parental relationship change and obesity

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=10,752)				
No	Reference category			
Yes	1.08	1.01	1.04	1.05
	0.79 - 1.46	0.75 - 1.37	0.77 - 1.40	0.78 - 1.43
Age 5 (N=10,930)				
No	Reference category			
Yes	1.28	1.19	1.24	1.25
	0.95 - 1.72	0.88 - 1.60	0.92 - 1.67	0.93 - 1.68
Age 7 (N=10,226)				
No	Reference category			
	0.93	0.90	0.91	0.91
Yes	0.68 - 1.27	0.65 - 1.24	0.66 - 1.26	0.66 - 1.26
Age 11 (N=8,625)				
No	Reference category			
Yes	1.11	0.89	0.95	0.95
	0.90 - 1.37	0.69 - 1.14	0.74 - 1.22	0.74 - 1.22

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Obesity regressed on parental relationship change
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Overweight

In contrast to the above, analysis of overweight showed a weak association of being exposed to parental relationship change with 32% greater odds of being overweight at age 7. This association remained significant at the 0.05 level for all models, with

estimate confidence intervals scarcely changing at all with adjustment for potential confounders. This was a standalone result, with no association found at other ages (Appendix 5, Table A5.25).

Table 5. 14 Odds ratios (95% CI) for multivariable logistic regression models showing the conditional association between parent-child conflict and obesity

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=10,752)				
No	Reference category			
Yes	1.09	1.07	0.91	0.92
	0.79 - 1.51	0.76 - 1.50	0.65 - 1.29	0.65 - 1.30
Age 5 (N=10,930)				
No	Reference category			
Yes	1.23	1.17	1.08	1.08
	0.91 - 1.65	0.86 - 1.59	0.79 - 1.48	0.79 - 1.48
Age 7 (N=10,226)				
No	Reference category			
	1.09	1.06	0.92	0.93
Yes	0.74 - 1.60	0.72 - 1.56	0.63 - 1.35	0.63 - 1.36
Age 11 (N=8,625)				
No	Reference category			
Yes	1.21	1.09	0.97	0.96
	0.91 - 1.62	0.80 - 1.50	0.71 - 1.33	0.70 - 1.32

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Obesity regressed on parent-child conflict
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Overweight

In contrast to the findings for obesity, parent-child conflict was associated with greater odds of being overweight at age 11. However, this association was not statistically significant in model 2, then became significant in models 3 and 4 at the 0.05 level, implying a weak association at best. There were no associations at any of the other ages (Appendix 5, Table A5.26).

5.4. 8 Maternal depression

Maternal depression was not associated with childhood obesity at ages 3, 5, or 7 years in any model. At age 11 in the unadjusted model, children whose mothers reported

depression had almost threefold higher odds of being obese (OR 2.84, CI 1.91 - 4.23), compared to children whose mothers did not report depression.

This association decreased with the addition of maternal characteristics and socioeconomic factors in the model but remained robust to full adjustment. In the fully adjusted model after accounting for LLI, parental relationship change and parent-child conflict, the odds of being obese were 63% higher for children exposed to maternal depression compared to children who were not exposed (table 5.15).

Table 5. 15 Odds ratios (95% CI) for multivariable logistic regression models showing the conditional association between maternal depression and obesity

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=10,752)				
No	Reference category			
Yes	0.91	0.73	0.66	0.71
	0.50 - 1.67	0.39 - 1.37	0.35 - 1.25	0.37 - 1.35
Age 5 (N=10,930)				
No	Reference category			
Yes	0.86	0.70	0.64	0.61
	0.50 - 1.47	0.39 - 1.25	0.36 - 1.13	0.34 - 1.07
Age 7 (N=10,226)				
No	Reference category			
	1.38	1.17	1.03	1.02
Yes	0.85 - 2.24	0.70 - 1.95	0.62 - 1.72	0.62 - 1.68
Age 11 (N=8,625)				
No	Reference category			
Yes	2.84***	2.19***	1.57*	1.63*
	1.91 - 4.23	1.44 - 3.32	1.04 - 2.36	1.08 - 2.47

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Obesity regressed on maternal depression
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Overweight

The sensitivity analysis supported findings from the main analysis, with maternal depression associated with obesity at age 11 only. Estimates mirrored the attenuation for cm, maternal and family socioeconomic characteristics observed in (Appendix 5, Table A5.27).

Analysis of maternal and paternal reported depression

When separate analyses were conducted for mothers and fathers, unadjusted estimates showed both maternal and paternal depression was associated with twice the odds of being obese for children at age 11, compared to those whose mothers and fathers did not report depressive symptoms. After adjustment for child and maternal characteristics, associations failed to reach statistical significance (see Appendix 5, tables A5.22 and A5.23).

5.4. 9 Summary of obesity analyses

Parental relationship change and parent-child conflict were not associated with childhood obesity at any age in both unadjusted and adjusted models. The stressors which pertain to parental health (LLI and maternal depression) did have significant associations with childhood obesity. Maternal and child characteristics fully attenuated the association between LLI and obesity, with much of the association explained by maternal pre-pregnancy BMI. However, at age 11 years the association between maternal depression and obesity remained significant after full adjustment for all confounding factors, including the other psychosocial stressors (LLI, parent relationship change and parent-child conflict). In a sensitivity analysis for paternal depression, unadjusted associations maintained findings for a relationship between parental depression and obesity at 11 years. Before progressing to longitudinal analyses, the cross-sectional results are discussed, including a comparison with the existing literature and examination of the strengths and limitations of the analysis.

5.5 Discussion

5.5. 1 Summary of results

Around one in ten of the children in the analytical sample had socioemotional difficulties at all ages, with children more likely to have socioemotional difficulties if they were obese (17.5%) or had been exposed to psychosocial stressors. Around one in twenty of the analytical sample were obese at all ages. Compared to their counterparts children exposed to parental relationship change, parental LLI and parent-child conflict were more likely to be obese at every age. Children of mothers with high depressive symptoms were over twice as likely to be obese (14% at age 11), compared to children whose mothers had not shown signs of depression (5%). The prevalence of both socioemotional difficulties and obesity were higher in more disadvantaged families.

Results for multivariable analysis lend support to hypothesis 1.1 as children exposed to psychosocial stressors were more likely to have socioemotional difficulties, and to a lesser extent, to be obese.

After final adjustment, children whose parents had a LLI had between 22-54% higher odds of total socioemotional difficulties, with the magnitude of association being larger at older ages. At age 5 only, the association between parental relationship change and socioemotional difficulties could not be explained by family characteristics or other stressors, with children exposed to relationship change 32% more likely to have socioemotional difficulties.

At each age, there were strong associations between parent-child conflict and children's socioemotional difficulties. Compared with others, children exposed to conflict were 3-7 times more likely to experience socioemotional difficulties, even after maternal characteristics, socioeconomic factors and other stressors were taken into account. Statistically adjusting for family and cohort child characteristics (including puberty) and other stressors did little to diminish associations.

At each age, having a mother with high depressive symptoms was associated with three times greater odds of a child having high socioemotional difficulties. The association was partially attenuated by family socioeconomic characteristics, but family and individual characteristics and other stressors did very little to explain the association between maternal depression and child socioemotional difficulties. The strength of the cross-sectional association, 2-3 times, was similar irrespective of the age at which it was examined.

Associations between psychosocial stressors and obesity were found only for stressors pertaining to parental health. There were no associations between parental relationship change or parent-child conflict and obesity. At ages 5, 7 and 11 years parental LLI was associated with around 30-40% greater odds of being obese, but these associations were fully attenuated after adjustment for hypothesised confounders. Maternal depression was also associated with obesity at age 11 and after full adjustment, children whose mothers had reported high depressive symptoms were 76% more likely to be obese, compared to children whose mothers did not. Compared to the other stressors examined, this shows maternal depression might have a greater influence over the day-to-day activities in children's lives that affect their BMI. To explore this association further, the longitudinal pathway from maternal depression to children's health behaviours are analysed in chapter 7. In chapter 6 the timing of exposure to stressors is investigated further.

5.5. 2 Comparison to the literature

Socioemotional difficulties

All stressors were associated with greater odds of high total difficulties. At every age, the largest associations between stressors and socioemotional difficulties were for parent-child conflict, followed by maternal depression. Both parent-child conflict and maternal depression are stressors which are likely to be more proximal to children's day-to-day experiences and more likely to affect their interactions with caregivers,

subsequently giving these stressors greater influence over children's mental health. Results support the theoretical framework which hypothesises that factors which are more proximal to children's day-to-day experiences will have the greatest influence on their physical and mental health, with the caveat that more distal factors in the developing child's environment, which are not assessed in this thesis, will also affect children's development in numerous ways (Bronfenbrenner, 1979, Bronfenbrenner, 1986).

The strongest association for parent-child conflict with socioemotional difficulties was at age 11 (although confidence intervals for estimates at ages 5 and 11 years did partially overlap), even after adjustment for measures of puberty. There are a number of possible explanations for this. Firstly, this could indicate that children might be more emotionally sensitive to psychosocial stressors in the home environment during pre-adolescence than earlier in childhood, regardless of puberty status. This could be because children are more aware of parental health at older ages and the emotional disruption of having a parent with a LLI has more influence on children's mental health as they mature. However, it is important to note that longitudinal constructs such as sensitive periods cannot be deduced from this cross-sectional analysis. A paper reviewing the impact of parental cancer on child psychological adjustment found older children (≥ 12 years) were more likely to report symptoms of anxiety and depression than younger children (Visser et al., 2004). As pre-adolescents are physically and cognitively more advanced, they may also face more caregiving tasks (Kraaij et al., 2003, Sieh et al., 2010).

Secondly, the stronger associations at age 11 could be due to residual confounding by puberty status. Puberty is associated with both socioemotional difficulties (Mensah et al., 2013) and obesity (Daniels et al., 1997) in childhood. Existing evidence suggests that children living in households characterised by stress can experience accelerated pubertal maturation (Ellis and Garber, 2000, Ellis et al., 2011, Kelly et al., 2017). It is possible that the physiological changes at the start of puberty are taking place without

any external indication, as pubertal maturation varies person to person, happening at different ages and rates of development (Dorn, 2006). The heightened hormones experienced during puberty could lead to increased emotionality in some children leading to greater parent-child conflict. Studies have suggested that as the brain undergoes changes during adolescence, pubertal hormones affect socioemotional development (Goddings et al., 2012, Dahl and Forbes, 2010).

Consistent with other studies using MCS (Kelly and Bartley, 2010), this thesis provides further evidence that links caregiver health to child socioemotional adjustment. Kelly and Bartley (2010) found that at age 5, children whose main carer had poor health were more than four times as likely to have high socioemotional difficulties scores as those with main carers in the best health group. International evidence also supports an association between parental health and children's socioemotional difficulties (Umberger et al., 2015, Quinn et al., 2014). In a study using data from the US National Survey on Child and Adolescent Well-Being (N=3,255), after accounting for child sex, age and ethnicity, regression analysis found caregiver mental and physical health mediated the relationship between high family stress and increased child internalising problems.

As stressors were associated with worse mental and physical health in children, there is evidence to support the Conger Family Stress Model (FSM). The FSM emphasises that experience of severe economic pressure affects parents' mental health and their relationships with co-parents, which negatively affects their behaviour towards children, harming children's development (Conger, 1994, Conger et al., 2010, Conger et al., 2002). Masarik and Conger (2017) suggest that the model can be applied to various other environmental stressors (Masarik and Conger, 2017).

After final adjustment, parental relationship change was only associated with socioemotional difficulties at age 5, although hypotheses based on the existing evidence of a negative effect of parental relationship change (Amato, 2005, Størksen et

al., 2006, Størksen et al., 2005) suggested an association would be observed at all ages. One explanation for the lack of association between parental relationship change and child socioemotional difficulties could be that the stigma surrounding divorce and one parent families has reduced significantly in recent decades, with greater support for single-parents and professional mediation for parents (Emery, 1999). After the addition of socioeconomic measures, associations between parental relationship and socioemotional difficulties at ages 3, 7 and 11 years were fully attenuated, consistent with the existing literature which finds that much of the association between parental relationship change and children's behaviour can be explained by socioeconomic factors (Burtless, 1999, Manning and Lamb, 2003). A study using data from the US National Longitudinal Study of Adolescent Health (13,231), which examined adolescent well-being in cohabiting, married and single-parent families, found that much of the bivariate differences in family structure can be explained by socioeconomic factors such as income and mother's education (Manning and Lamb, 2003). Supporting this, in the UK, analysis of MCS has shown that children living with consistently married parents have the most advantageous SEP (Panico et al., 2010).

Similar to the findings of this thesis, studies have found associations between maternal depression and children's cognitive and emotional well-being at all ages during childhood, even after accounting for social and economic factors (Ashman et al., 2008, Lovejoy et al., 2000, Kiernan and Huerta, 2008). Keirnan and Huerta (2008) examined the effects of maternal depression on child development using MCS, they found that prior depression, recent onset and persistent depression were all significantly related to children's socioemotional difficulties at age three, with the strongest association for persistent depression. However, this study only looks at outcomes at age 3. To explore the timing of exposure to maternal depression and its longitudinal effects, the analysis in the next chapter will examine stressors longitudinally across the first decade of life.

Compared with estimates for the effects of maternal measures of ill health, the analysis showed weaker associations between paternal reported depression and LLI with

socioemotional difficulties for children, indicating that paternal depression might have some effect on caregiving and family functioning but to a lesser extent than maternal depression. Multiple UK studies support the association between paternal depression and children's socioemotional difficulties (Ramchandani et al., 2008a, Ramchandani et al., 2008b) but research and interventions have tended to focus on maternal mental health (Wong et al., 2016, Panter-Brick et al., 2014). Ramchandani and colleagues (2008a) examined the effects of father's depression on children's subsequent socioemotional difficulties using ALSPAC data. After adjustment for sociodemographic factors, they found boys whose fathers reported symptoms of depression in the postnatal period had over twice the risk of Rutter scale assessed conduct problems at age 3 years (Ramchandani et al., 2008a). Their study found a similar effect size compared to in the current analysis (OR:1.78 $p<0.05$), supporting the findings of this thesis.

We found some evidence of a reporter effect for socioemotional difficulties, with stressors having smaller associations with teacher-reported socioemotional difficulties compared to parent-reported difficulties. This finding is supported by studies that suggest informant reporting patterns differ between parents and teachers (Brown et al., 2006, MacLeod et al., 1999). There are two possible explanations for discrepancies; 1) parents may over-report children's difficulties due to their own mental health difficulties, for example, if a mother has depressive symptoms she might be more likely to report socioemotional difficulties in her child (Gartstein et al., 2009, Ordway, 2011), and 2) children's symptoms, or opportunities to observe them, may vary across home and school contexts (Brown et al., 2006). As the models adjust for maternal depression it is unlikely that maternal mental health is driving the discrepancies between parent and teacher reports. Rather, there is more support that the discrepancies in associations between stressors and socioemotional difficulties are due to differences in the home and classroom behaviours.

Obesity

At age 11, children whose mothers reported high depressive symptoms were 76% more likely to be obese. This was the only association between a psychosocial stressor

and obesity to remain robust to adjustment. These findings add to the literature because most studies have not looked at exposure past eight years of age (Lampard et al., 2014b). This evidence supports a stronger association between stressors and weight status at older ages in childhood. This may be because children are beginning the transition into adolescence and are therefore less reliant on parental provision of food, coupled with a decrease in participation in physical activity (Todd et al., 2015). One pathway from maternal depression to childhood obesity could be that by pre-adolescence children may be more aware of health behaviours associated with their mother's depressive symptoms. Adults with depressive symptoms are more likely to eat high energy diets (Oliver and Wardle, 1999, Torres and Nowson, 2007) or eat more to distract or reduce negative feelings (Haedt-Matt and Keel, 2011, Wurtman and Wurtman, 1995), have increased sedentary behaviours and do less physical activity (Wemme and Rosvall, 2005, Walton et al., 2014). In pre-adolescence, mother's depression might affect children's day-to-day health behaviours and, as children's eating behaviours are shaped by the habits of their caregivers (Savage et al., 2007, Birch and Davison, 2001), it is possible children will adopt these health behaviour themselves.

A symptom of depression can also be a reduction in appetite (Simmons, 2016). Studies in developing countries have found positive associations between maternal depression and children's underweight and stunting (Santos et al., 2010, Surkan et al., 2014, Surkan et al., 2011). However, as so few children are underweight in the MCS, analysis of the relationship between maternal depression and underweight was not possible.

Many studies have found maternal pre-pregnancy BMI is highly predictive of children's BMI (Castillo et al., 2015, Yu et al., 2013) with mothers who are obese more likely to have children who are obese (Linabery et al., 2013). Two possible explanations for this relationship are; 1) genetic similarities between the mother and child (Linabery et al., 2013), and 2) the shared environment which impacts on children's and mother's health behaviours (Swanton et al., 2017). To account for this I adjusted for maternal pre-

pregnancy BMI. After adjustment, there was a small amount of attenuation for the relationship between maternal depression and children's obesity indicating that maternal characteristics only partially explain the association between maternal depression and childhood obesity. Instead, greater attenuation was shown after adjustment for family socioeconomic variables indicating that these factors had a stronger confounding influence.

5.5. 3 Strengths and limitations

The MCS is a rich dataset, making it possible to analyse four measures of psychosocial stress in the home environment on two health outcomes at four age points across the first decade of life. Although unable to capture the full and complex picture of children's home environments that are characterised by all possible psychosocial stressors, the measures of psychosocial stress that are used in this research are varied and widely discussed in the existing literature (Sieh et al., 2010, Quinn et al., 2014, Kelly and Bartley, 2010, Amato, 2005, Størksen et al., 2005, Afifi et al., 2013, Weaver et al., 2015, Miller et al., 2000, Ashman et al., 2008, Kiernan and Huerta, 2008, Ramasubramanian et al., 2013).

A second strength of this work is that the analysis was able to account for a number of potential confounders. The research adjusts for SEP by using 3 separate measures to resolve the complexity of measuring household SEP. In addition, to account for some genetic susceptibility to obesity and the dietary environment of the developing child, the analysis adjusts for pre-pregnancy BMI.

A further strength of this research is the analyses of paternal depression on children's health, as well as using paternal and teacher-reported socioemotional difficulties to better understand the association between maternal depression and child socioemotional difficulties. To further discern results, chapter 6 will analyse how health behaviours and family structure might moderate associations between stressors, socioemotional difficulties and obesity.

To understand if externalising or internalising behaviour were driving associations for socioemotional difficulties, subscale analyses were conducted. In addition, using the exemplar stressor of maternal depression, a further model examined whether opposite subscales were confounding associations for internalising and externalising difficulties. This showed some further attenuation by subscales. Future analysis could explore this further.

Sumilo et al (2013) analysed the association between maternal LLI and children's health in MCS and found that the most commonly reported LLIs were different musculoskeletal disorders, asthma and recurrent depressive disorder of maternal depression, showing that the measure collects data on varied illnesses. A limitation of the study is that LLI includes any number of illnesses which might limit a person's day-to-day activities and captures many varied states of health, such as maternal depression. However, the relationship between LLI and socioemotional difficulties remained significant at every age after adjustment for maternal depression. Instead of more general measures of health, limiting longstanding illness captures all and any illnesses which have a debilitating impact on day-to-day activities, making it potentially a better measure of parental illness as a possible psychosocial stressor in the home environment.

A further limitation is that at age 11 the Conflict Tactics scale was not available, so a question on whether or not parents have frequent battles with children was used as a measure of parent-child conflict. The increase in effect size for the association between parent-child conflict and socioemotional difficulties at age 11 might be due to the difference in measurement. However, just one item might be expected to suffer from less covariance than a scale.

This chapter used cross-sectional analyses to examine the associations between psychosocial stressors in the home environment, socioemotional difficulties and obesity at four separate time points throughout childhood. Results for multivariable analysis showed children exposed to psychosocial stressors were more likely to have

socioemotional difficulties, and to a lesser extent, to be obese. To better account for the duration of exposure of stressors and children's outcomes, the next chapter (chapter 6) will use longitudinal analysis.

Chapter 6: Longitudinal analysis of psychosocial stressors, socioemotional difficulties and obesity

The second objective of this research is to examine the longitudinal pathways from exposure to psychosocial stressors at repeated time points in childhood with socioemotional difficulties and obesity in pre-adolescence. The initial hypothesis is that exposure to stressors earlier in childhood will be associated with greater odds of having high socioemotional difficulty scores and obesity in pre-adolescence. The second hypothesis is that, compared to experiencing stressors in the past (ages 3, 5, or 7) or present (age 11) only, exposure to stressors in the past and concurrently will have a stronger association with socioemotional difficulties and obesity. This chapter begins with the explanation of how a single variable was derived to represent children's exposure to each stressor at four time points, then goes on to discuss the analytical sample and multivariable regression results, ending with a discussion of the results in comparison to the existing literature and the strengths and limitations of the analysis.

6.1. Analytical approach

For each of the psychosocial stressors (limiting longstanding illness (LLI), relationship change, parent-child conflict; and maternal depression), a variable was created to capture how exposure might be categorised over time. Data from all four time points (3, 5, 7, and 11 years) were used to generate four categories:

1) Never (not exposed to the stressor at any of 3, 5, 7 and 11);
2) Past (exposed to stressor at 3 and/or 5 and/or 7 years);
3) Present (exposed to stressor at age 11 years only);
4) Past and present (exposed to stressor at 3 and/or 5 and/or 7, and at age 11 years).

Originally the fourth category was exposure to the stressor at every data collection sweep, but there were too few cohort members categorised as such for meaningful analysis. Multivariable logistic regressions were used to examine the associations

between longitudinal stressor variables and socioemotional difficulties at age 11 years using the following analytical models.

6.1. 1 Analytical models to examine the associations between longitudinal stressors and socioemotional difficulties

The models below were run using total socioemotional difficulties as an outcome followed by externalising and internalising subscales.

Model 1: Socioemotional difficulties regressed on longitudinal stressor (limiting longstanding illness; relationship change; parent-child conflict; or maternal depression)

Model 2: Model 1 + CM and maternal characteristics (CM socioemotional difficulties at age 3, CM sex, CM obesity at age 11, CM puberty by sex interaction, maternal age and maternal smoking status)

Model 3: Model 2 + family socioeconomic characteristics (income, occupational class and parental education) at age 3

Model 4: Model 3 + other longitudinal stressors (for example, when limiting longstanding illness (LLI) was entered into model 1 additional stressor variables added in this model were relationship change; parent-child conflict; and maternal depression)

6.1. 2 Analytical models to examine the associations between longitudinal stressors and obesity

Using the following analytical models, multivariable logistic regressions were used to examine the associations of stressors with obesity. These models differ to the above models for the socioemotional difficulties analysis because they additionally adjust for maternal BMI and there was no evidence of a puberty by sex interaction for obesity models:

Model 1: Obesity regressed on longitudinal stressor (limiting longstanding illness; relationship change; parent-child conflict; or maternal depression)

Model 2: Model 1 + CM and maternal characteristics (CM obesity at age 3, CM sex, CM socioemotional difficulties at age 11, CM puberty, maternal BMI, maternal age and maternal smoking status)

Model 3: Model 2 + family socioeconomic characteristics (income, occupational class and parental education) at age 3

Model 4: Model 3 + other longitudinal stressors (LLI; relationship change; parent-child conflict; maternal depression)

6.2. Analytical sample

There are different sample sizes for socioemotional difficulties and obesity analyses. This is due to different response rates at each sweep, different response rates for the study outcomes and because pre-pregnancy BMI was included in the obesity models but not the socioemotional difficulties analyses.

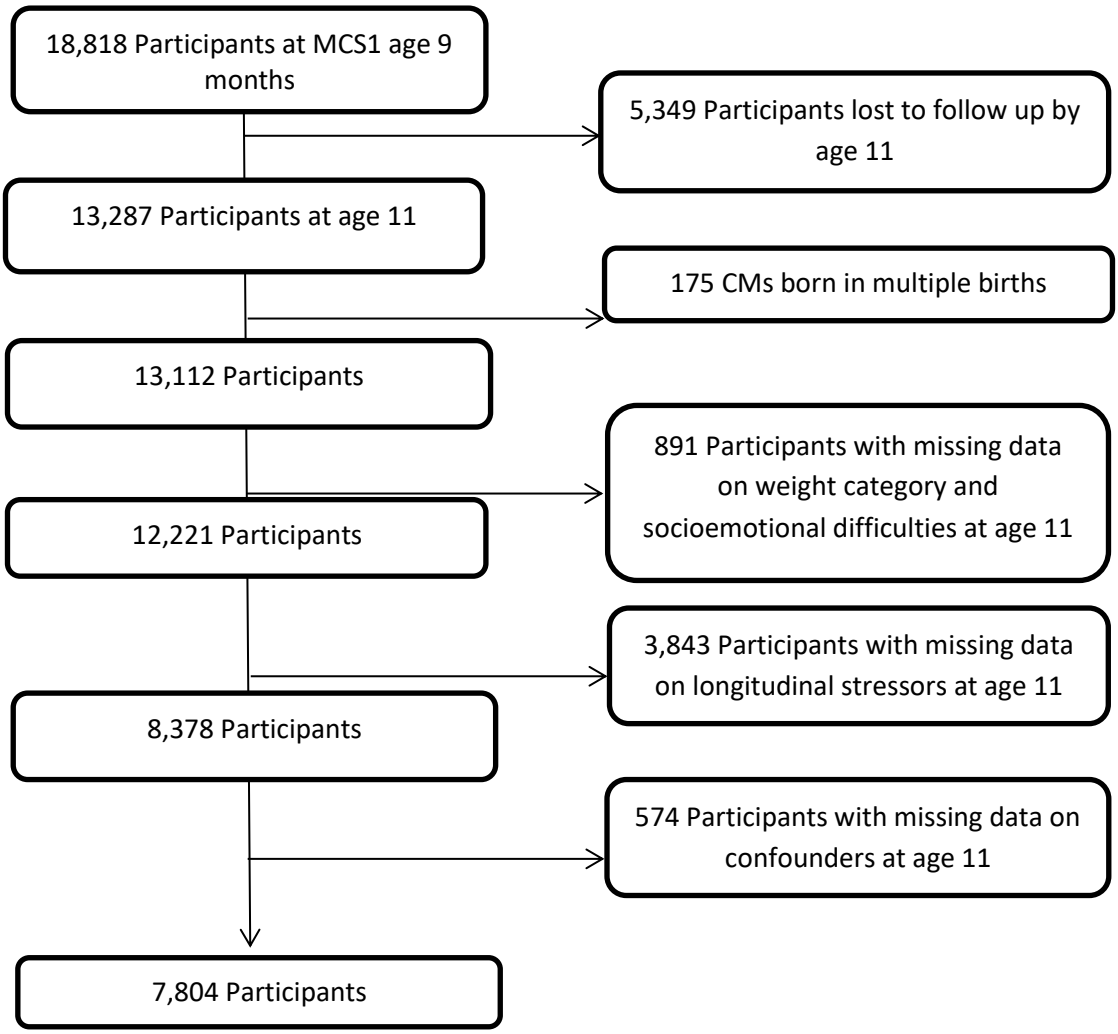

Figure 6. 1 Longitudinal stressor and socioemotional difficulties analysis sample

Figures 6.1 and 6.2 depict how the analytical samples were derived for both outcomes. For models where socioemotional difficulties was the outcome, after excluding children born in multiple births (n=175) there were 7,804 at age 11 years with complete data on stressors, confounders, obesity and socioemotional difficulties. After additionally controlling for pre-pregnancy BMI in the obesity model the sample size was 7,017.

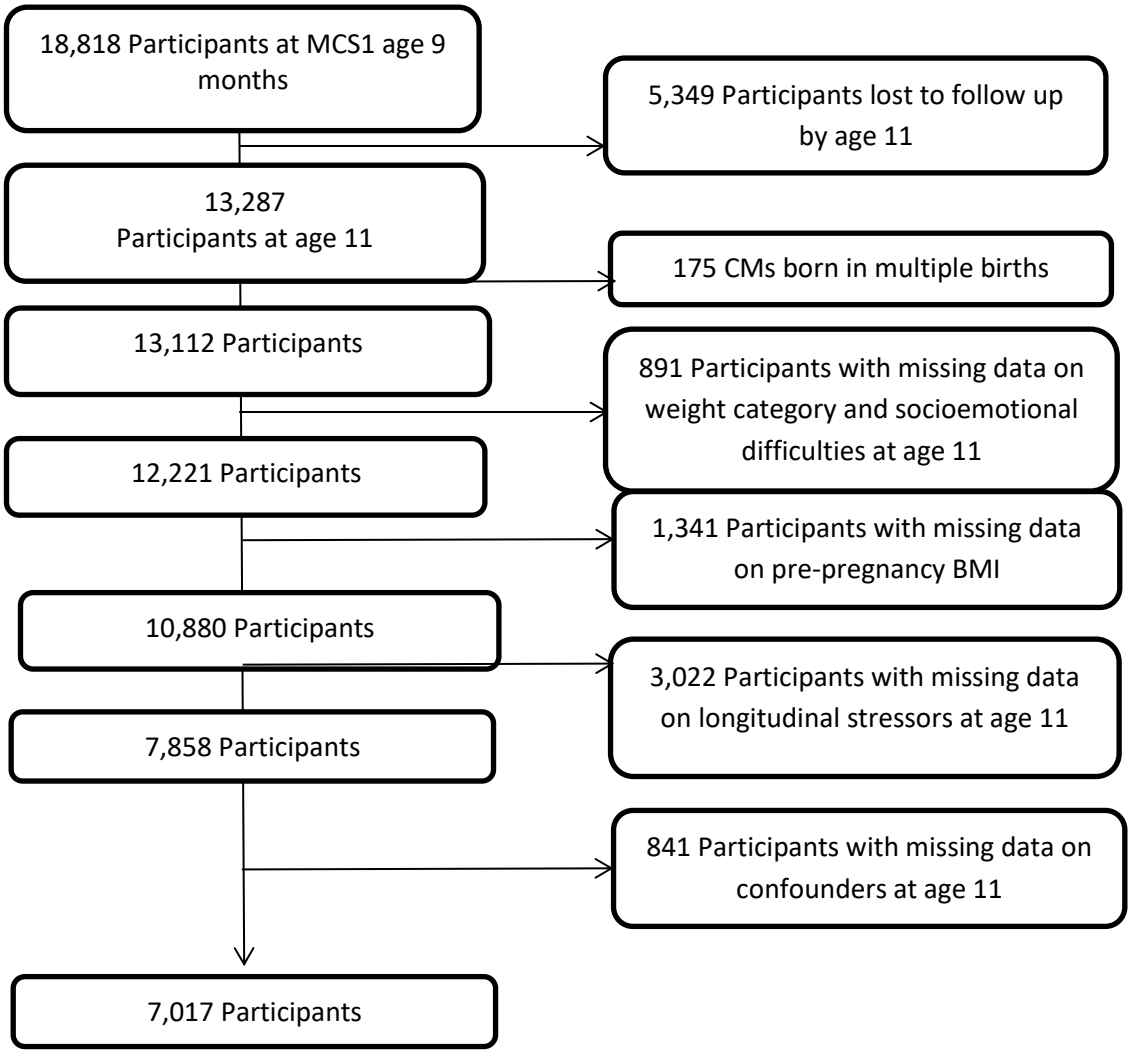

Figure 6. 2 Longitudinal stressor and obesity analysis sample

6.3 Results

6.3. 1 Descriptive results

Table 6.1 outlines the characteristics of socioemotional difficulties (N= 7,804) and obesity (N= 7,017) samples for longitudinal stressor models. The demographic and socioeconomic characteristics of these samples were very similar to findings for cross-sectional models in the previous chapter. With regards to the study outcomes, 8.7% of the sample had high socioemotional difficulties and 5.6% were obese at age 11.

Sixty per cent of the sample were never exposed to parental LLI and just fewer than 10% were exposed in the past or present only. Thirty per cent were exposed during the past and at age 11.

Thirty per cent of parents went through a relationship change at least once during the first decade of children's lives. If parents had been through a relationship change, often they went through more than one, with 20% of the sample having gone through a relationship change at one time point or more in the past (between 9 months and 7 years) and again at the present sweep (between 7 and 11 years). Three per cent of children's parents had a relationship change at least once in the past, from 9 months to 7 years, but not between 7 and 11 years.

The most prevalent stressor children were exposed to across the four data collection sweeps was parent-child conflict (see table 6.1). Just over 42% (in both samples) were categorised as never having been exposed to parent-child conflict, meaning the majority of the sample were exposed to parent-child conflict at one time point or more. Most children who were exposed to conflict were exposed at one or more time points in the past and again at age 11 (37%). A small proportion of children had been exposed to conflict at one time point or more in the past (1%) and 19% were exposed at age 11 only.

Table 6. 1 Descriptive characteristics of longitudinal stressor samples (weighted %)

	Socioemotional difficulties sample (N= 7,804)	Obesity (N= 7,017)
Outcomes	%	%
Socioemotional Difficulties		
Low /Borderline	91.3	91.4
High	8.7	8.6
Weight Category		
Not obese	94.0	94.3
Obese	6.0	5.6
Stressors		
Limiting longstanding illness		
Never	60.8	60.7
Past	5.2	5.1
Present	4.4	4.5
Past &Present	30.0	29.6
Parental relationship change		
Never	68.5	69.3
Past	3.0	3.1
Present	7.6	7.7
Past &Present	20.9	19.9
Parent-child conflict		
Never	42.6	42.5
Past	1.1	1.0
Present	19.3	19.2
Past &Present	37.1	37.3
Maternal depression		
Never	89.4	89.7
Past	1.4	1.3
Present	3.0	2.9
Past &Present	6.2	6.0
Cohort member characteristics		
Sex		
Male	51.0	50.5
Female	49.0	49.5
Puberty Status		
Not begun	87.0	86.9
Has begun	13.0	13.1
Maternal smoking status		
Non-smoker	80.0	79.8
Smoked	20.0	20.2

Table 6.1 (continued) Descriptive characteristics of longitudinal stressor samples (weighted %)

Categorical Variables	Socioemotional difficulties sample (N= 7,804)	Obesity sample (N= 7,017)
Family socioeconomic characteristics		
Income Quintiles		
Highest quintile	21.2	21.9
Fourth quintile	21.8	22.1
Third quintile	21.5	21.5
Second quintile	18.8	18.8
Lowest quintile	16.7	15.7
Occupational class		
Managerial / professional	45.7	46.6
Intermediate	12.9	12.9
Small employers	6.0	6.0
Lower supervisory / technical	6.7	6.8
Semi-routine and routine	1.0	9.9
Unemployed / student	18.8	17.8
Education		
NVQ level 5	5.1	4.6
NVQ level 4	1.0	1.0
NVQ level 3	5.0	4.9
NVQ level 2	25.1	24.9
NVQ level 1	16.8	17.1
Overseas qualification only	39.7	40.1
None of these	7.3	7.4

Of the four stressors, children were least likely to be exposed to maternal depression, with 90% of the sample never having been exposed to it. There were more mothers who had depressive symptoms at a past time point and again at age 11 (6%, table 6.1), compared to just at a past sweep (just over 1%) or at age 11 (3%).

As the eligible longitudinal MCS sample was reduced due to missing data on all covariates except for sex and income, which had complete data, analysis to examine the distribution of outcomes, stressors and confounders in omitted and analysis samples. Table 6.2 presents the number of participants with missing data and the total number of the eligible MCS sample for longitudinal analysis for each category of the variables used in the analysis. Children who were not included in the analytical sample

were more likely to have socioemotional difficulties at baseline (age 3), and age 11, to be exhibiting signs of early puberty, to have mothers who smoked during pregnancy. The analytical sample were from more advantaged households and had a lower prevalence of stressors.

Table 6. 2 Distribution of outcomes, stressors, and confounders in omitted and analytical sample

Covariates	Omitted from sample (%)	Analytical sample* (%)	% missing
Socioemotional difficulties at age 11			
Low /Borderline	4,257 (87.1)	7,197 (91.3)	39.7%
High	523 (12.9)	607 (8.7)	20.7%
Total	4,780	7,804	40.9%
Weight Category at age 11			
Not obese	4,538 (92.8)	7,315 (94.0)	40.8%
Obese	360 (7.1)	489 (6.0)	45.5%
Total	4,898	7,804	41.2%
Cohort member characteristics			
Baseline Total Difficulties**			
Normal /Borderline	2,724 (81.0)	6,911 (87.2)	31.2%
Abnormal	593 (19.0)	893 (12.8)	42.0%
Total	3,317	7,804	32.8%
Baseline Weight Category***			
Not obese	3,495 (93.7)	6,920 (95.0)	36.0%
Obese	234 (6.3)	383 (5.0)	41.6%
Total	3,729	7,303	36.3%
Sex			
Male	2,722 (52.7)	3,913 (51.0)	44.0%
Female	2,586 (47.3)	3,891 (49.0)	42.3%
Total	5,308	7,804	43.1%
Puberty Status			
Not begun	3,410 (81.7)	6,808 (87.0)	36.6%
Has begun	748 (18.3)	996 (13.0)	46.5%
Total	4,158	7,804	38.1%
Maternal Smoking Status			
Non-smoker	3,841 (76.8)	6,334 (80.0)	39.5%
Smoked	997 (23.2)	1,470 (20.0)	44.1%
Total	4,838	7,804	40.5%
Maternal Pre-Pregnancy BMI***			
Not overweight	3,014 (73.0)	5,197 (71.5)	39.4%
Overweight	869 (19.1)	1,500 (19.6)	38.4%
Obese	362	660	36.3%
Total	4,245	7,357	39.0%

*Longitudinal socioemotional difficulties analysis sample
**For socioemotional difficulties analysis only ***For obesity analysis only

Table 6.2 (continued) Distribution of outcomes, stressors, and confounders in omitted and analytical sample

Covariates	Omitted from sample (%)	Analytical sample* (%)	% missing
Family socioeconomic characteristics			
Income Weighted Quintiles			
Highest quintile	517 (12.0)	1,727 (21.2)	24.7
Fourth quintile	551 (12.4)	1,755 (21.8)	24.8
Third quintile	676 (17.1)	1,695 (21.5)	31.5
Second quintile	1,043 (24.7)	1,449 (18.8)	43.2
Lowest quintile	1,262 (33.7)	1,178 (16.7)	53.8
Total	4,049	7,804	36.6
Occupational class			
Managerial/professional	1,313 (29.2)	4,024 (48.6)	26.1
Intermediate	461 (10.3)	1,188 (15.2)	28.6
Small employers	401 (10.0)	501 (6.7)	46.6
Lower supervisory and technical	340 (8.0)	644 (8.6)	35.4
Semi-routine and routine	1,238 (32.0)	1,329 (18.8)	50.1
Unemployed / student	377 (10.5)	118 (2.0)	76.0
Total	4,130	7,804	37.1
Education			
NVQ level 5	274 (5.3)	676 (7.3)	30.1
NVQ level 4	1,087 (23.3)	3,283 (39.7)	25.8
NVQ level 3	589 (13.8)	1,336 (16.8)	32.6
NVQ level 2	1,046 (27.5)	1,771 (25.1)	39.4
NVQ level 1	320 (8.7)	337 (5.0)	50.5
Overseas only	182 (4.1)	79 (1.0)	71.0
None of these	639 (17.2)	322 (5.1)	66.8
Total	4,137	7,804	37.2
Stressors			
Limiting longstanding illness			
Never	1,796 (42.2)	4,704 (60.8)	26.6
Past	256 (6.8)	412 (5.2)	40.6
Present	337 (10.3)	355 (4.4)	55.2
Past & Present	1,532 (40.6)	2,333 (29.7)	41.7
Total	3,921	7,804	34.3
Parental relationship change			
Never	1,701 (47.8)	5,554 (68.5)	22.2
Past	128 (4.7)	221 (3.0)	39.2
Present	361 (12.4)	569 (7.6)	40.0
Past & Present	831 (35.1)	1,460 (20.9)	40.7
Total	3,021	7,804	29.0

*Longitudinal socioemotional difficulties analysis sample
**For socioemotional difficulties analysis only ***For obesity analysis only

Table 6.2 (continued) Distribution of outcomes, stressors, and confounders in omitted and analytical sample

Stressors	Omitted from sample (%)	Analytical sample* (%)	% missing
Parent-child conflict			
Never	638 (20.3)	3,400 (42.6)	16.5
Past	76 (2.0)	79 (1.1)	43.5
Present	1,036 (36.8)	1,461 (19.3)	44.3
Past & Present	1,092 (40.9)	2,864 (37.1)	31.4
Total	2,842	7,804	29.4
Maternal depression			
Never	983 (62.5)	7,061 (89.4)	13.1
Past	70 (4.8)	99 (1.4)	43.2
Present	194 (13.3)	212 (3.0)	49.4
Past & Present	286 (19.3)	432 (6.2)	40.3
Total	1,533	7,804	17.8

*Longitudinal socioemotional difficulties analysis sample
**For socioemotional difficulties analysis only ***For obesity analysis only

Further analysis was conducted to understand whether the distribution of socioemotional difficulties and obesity differed between the omitted sample and analytical samples. Table 6.3 presents the prevalence of socioemotional difficulties and obesity in longitudinal analyses sample and omitted sample by confounders and stressors. The distribution of obesity across the samples by all other characteristics was relatively similar, with 11% of the omitted sample children who had high socioemotional difficulties obese, compared to 10% for the children in the analytical sample. The distribution of socioemotional difficulties across the two samples, by all other characteristics, showed that children who were omitted from the sample were more likely to have socioemotional difficulties. For example, of the children who were obese, 18% of the omitted sample had high socioemotional difficulties compared to 16% in the analytical sample.

Table 6. 3 Prevalence (%) of socioemotional difficulties and obesity in longitudinal analysis samples and omitted sample by confounders and stressors

	Socioemotional difficulties %		Obesity %	
Cohort member characteristics	Omitted from sample (N=5,308)	Analytical sample (N=7,804)	Omitted from sample (N=6,095)	Analytical sample (N=7,017)
Total Difficulties				
Low /Borderline	N/A		6.8	5.2
High			11.1	10.1
Weight Category				
Not obese	12.1	8.2	N/A	
Obese	18.4	15.8		
Sex				
Male	15.7	10.6	7.4	5.2
Female	9.8	6.6	7.3	6.0
Puberty Status				
Not begun	13.0	8.2	6.9	5.1
Has begun	15.6	11.8	10.5	9.4
Maternal smoking status				
Non-smoker	12.4	7.5	7.0	4.8
Smoker	14.9	13.4	8.9	8.8
Family socioeconomic characteristics				
Income Quintiles				
Highest quintile	2.7	2.9	3.1	3.0
Fourth quintile	6.5	6.3	5.7	4.7
Third quintile	7.9	7.7	6.1	5.9
Second quintile	16.7	13.0	8.3	6.9
Lowest quintile	18.7	15.4	9.0	8.8
Occupational class				
Managerial and professional	6.4	5.2	4.6	3.8
Intermediate	9.1	9.1	5.7	6.0
Small employers	9.6	6.0	6.0	6.2
Lower supervisory and technical	17.0	12.0	11.1	7.4
Semi-routine and routine	18.1	15.1	9.1	8.6
Unemployed, student, never worked	18.3	23.5	8.8	13.7
Education				
NVQ level 5	2.7	2.9	3.3	1.0
NVQ level 4	6.6	5.6	4.5	4.5
NVQ level 3	10.3	8.9	7.9	5.7
NVQ level 2	13.2	11.9	8.7	6.6
NVQ level 1	21.2	13.0	7.5	8.9
Overseas qualification only	14.4	19.6	13.0	13.3
None of these	21.1	18.2	8.0	12.9

Table 6.3 (continued) Prevalence (%) of socioemotional difficulties and obesity in longitudinal analysis samples and omitted sample by confounders and stressors

	Socioemotional difficulties %		Obesity %	
Stressors	Omitted from sample (N=5,308)	Analytical sample (N=7,804)	Omitted from sample (N=6,095)	Analytical sample (N=7,017)
Limiting longstanding illness				
Never	8.9	6.5	6.3	4.7
Past	11.2	7.1	4.9	4.7
Present	17.9	14.3	8.5	3.6
Past & Present	17.7	12.5	8.7	8.0
Parental relationship change				
Never	9.7	6.5	6.9	5.0
Past	9.3	9.2	9.6	10.8
Present	10.4	13.1	6.3	6.9
Past & Present	16.4	14.0	8.3	6.4
Parent-child conflict				
Never	2.2	2.6	5.3	5.2
Past	5.6	7.4	7.9	7.0
Present	23.5	11.1	7.6	5.7
Past & Present	20.9	14.4	8.2	6.1
Maternal depression				
Never	8.3	6.3	5.6	5.1
Past	19.0	23.8	12.6	9.5
Present	34.4	32.8	12.2	11.9
Past & Present	30.0	27.2	10.6	9.6

6.4 Multivariable regression results

This next section of chapter 6 reports the results from the multivariable logistic regression analysis of longitudinal stressors, socioemotional difficulties and obesity.

Socioemotional difficulties

6.4. 1 Limiting longstanding illness (LLI)

Table 6.4 shows the results for multivariable analysis of socioemotional difficulties regressed on longitudinal stressors. In the unadjusted model exposure to LLI in the present, and in the past and present, compared to never, were associated with over a twofold increase in odds of experiencing high socioemotional difficulties at age 11. There was no association between past LLI and socioemotional difficulties.

After adjustment for cohort member and maternal characteristics, the likelihood of high socioemotional difficulties remained for in the present, and in the past and present categories (Model 2 ORs 2.09 and 1.72, respectively). There was another small reduction in the association after statistically controlling for family socioeconomic factors (Model 3 aORs 1.98 and 1.59, respectively). In the final model, associations were fully attenuated by other stressors (relationship change, parent-child conflict and maternal depression).

Externalising and internalising difficulties

Separate analyses were performed for internalising and externalising difficulties (N=7,810). In contrast to analysis for total socioemotional difficulties, the association between past and present exposure to LLI and externalising difficulties remained robust to full adjustment (OR 1.39, CI1.16-1.68), with exposed children 39% more likely to have high externalising difficulty scores. In comparison, the association between present, and past and present exposure to LLI and internalising difficulties also remained robust to full adjustment. For internalising difficulties, associations were larger: children from families with present parental LLI were 71% more likely, and past

and present 41% more likely, to have internalising difficulties at age 11 years (see Appendix 6, tables A6.1 and A6.2).

Table 6. 4 Odds ratios (95% CI) for multivariable logistic regression models showing the associations between longitudinal stressors and socioemotional difficulties at age 11 years

Stressors (N=7,804)	Model 1	Model 2	Model 3	Model 4
Limiting longstanding illness				
Never	Reference category			
Past	1.10	1.13	1.15	1.13
	0.72 - 1.68	0.75 - 1.69	0.77 - 1.71	0.74 - 1.71
Present	2.39***	2.09**	1.98**	1.51
	1.59 - 3.57	1.31 - 3.33	1.23 - 3.19	0.90 - 2.53
Past	2.05***	1.72***	1.59***	1.28
&Present	1.68 - 2.51	1.39 - 2.13	1.28 - 1.97	1.00 - 1.65
Relationship change				
Never	Reference category			
Past	1.45	1.00	0.89	0.83
	0.89 - 2.36	0.56 - 1.78	0.50 - 1.59	0.44 - 1.55
Present	2.16***	1.80***	1.69**	1.65**
	1.57 - 2.97	1.29 - 2.52	1.20 - 2.36	1.17 - 2.33
Past	2.34***	1.56**	1.37*	1.20
&Present	1.82 - 3.02	1.16 - 2.11	1.01 - 1.88	0.86 - 1.68
Parent-child conflict				
Never	Reference category			
Past	2.95*	2.10	2.08	1.49
	1.02 - 8.57	0.67 - 6.57	0.66 - 6.48	0.37 – 5.92
Present	4.63***	4.16***	4.30***	4.05***
	3.33 - 6.44	2.96 - 5.85	3.04 - 6.06	2.83 - 5.80
Past	6.23***	4.30***	4.67***	4.33***
&Present	4.52 - 8.58	3.09 - 5.99	3.33 - 6.56	3.07 - 6.10
Maternal depression				
Never	Reference category			
Past	4.62***	3.96***	3.36***	3.06***
	2.76 - 7.74	2.32 - 6.79	1.94 - 5.84	1.70 - 5.51
Present	7.20***	5.74***	5.34***	4.55***
	5.21 - 9.94	3.88 - 8.48	3.59 - 7.94	3.06 - 6.75
Past	5.52***	3.51***	3.17***	2.52***
&Present	4.00 - 7.61	2.41 - 5.11	2.19 - 4.57	1.67 - 3.78

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on stressor (limiting longstanding illness; relationship change; parent-child conflict; or maternal depression)
Model 2: Model 1 + cohort member (CM) and maternal characteristics
Model 3: Model 2 + baseline family socioeconomic characteristics
Model 4: Model 3 + other longitudinal stressors

6.4. 2 Relationship change

Compared to children whose parents had not experienced a relationship change, children who were exposed to present, and past and present, parental relationship

change were more likely to have high socioemotional difficulties (unadjusted ORs 2.16 and 2.34, respectively). Adjustment for child and maternal characteristics and family SEP reduced the size of associations between present, and past and present, parental relationship change and socioemotional difficulties (aOR 1.69 and 1.37, respectively). Only associations with present relationship change were robust to full adjustment for other stressors (LLI, parent-child conflict and maternal depression, see table 6.4), with children exposed to relationship change since age 7 years experiencing 65% higher odds of high socioemotional difficulties (95% CI 1.17 - 2.33). For present relationship change, there was approximately a 35% overall reduction in log odds in fully adjusted models.

Externalising and internalising difficulties

Subscale analysis found robust longitudinal and cross-sectional associations between parental relationship change and children's behavioural difficulties. Present, and past and present relationship change remained associated with externalising difficulties after full adjustment (aORs 1.52 and 1.30 respectively). Compared to counterparts who did not experience parental relationship change, children exposed to past relationship change were 75% more likely to have high internalising difficulties (see Appendix 6, tables A6.1 and A6.2).

6.4. 3 Parent-child conflict

Parent-child conflict experienced at any time in childhood was associated with socioemotional difficulties in unadjusted models. Past, compared to never, had the smallest magnitude of association (OR 2.95, 95% CI 1.02 - 8.57), followed by present (OR 4.63, 95% CI 3.33 - 6.44) and past and present (OR 6.23, 95% CI 4.52 - 8.58), however, different categorisations of exposure had large, overlapping confidence intervals. After adjustment for child and maternal characteristics, the association between past conflict and socioemotional difficulties was fully attenuated. Present, and past and present, conflict associations were reduced by adjustment for child and

maternal characteristics (aORs 4.16 and 4.30, respectively) and additional adjustment for family SEP (aORs 4.30 and 4.67, respectively). In the final model, present, and past and present conflict remained robust to full adjustment and both categories, compared to never, were independently associated with over fourfold greater odds of high socioemotional difficulties (see table 6.4). Overall, adjustment for confounding factors resulted in a smaller reduction in log odds for the association between present exposure to conflict and socioemotional difficulties (9%), compared to past and present exposure (20%).

Externalising and internalising difficulties

For both subscales, there were robust associations for exposure to present, and for past and present parent-child conflict and children's behaviour. Compared to children who were never exposed, children who were exposed to conflict at age 11, were at risk of fivefold greater odds of conduct and hyperactivity problems (OR 4.99, 95% CI 3.98-6.25). In comparison, the same children were at risk of a twofold increase in odds of internalising difficulties (see Appendix 6, tables A6.1 and A6.2). Confounding factors only explained a small amount of the associations. For example, the final statistical adjustment for confounding factors explained 10% of the association between present parent-child conflict and internalising difficulty scores, and 1% for the association between present conflict and externalising difficulty scores.

6.4. 4 Maternal depression

Maternal depression experienced at any time in childhood was associated with a greater likelihood of high socioemotional difficulties in children. Associations were somewhat attenuated by child and maternal characteristics, for example, odds ratios for past and present maternal depression decreased approximately by a third in Model 2 (Model 1: OR 5.52 and Model 2: aOR 3.51, table 6.4). In Model 3, associations were reduced further by the introduction of family SEP into the model. Maternal depression was the only longitudinal stressor to have all categories of exposure robust to full

adjustment. In the final model, compared to children who were never exposed to maternal depression, present exposure to maternal depression at age 11 was associated with five times the likelihood of a child having high socioemotional difficulties.

Externalising and internalising difficulties

Maternal depression was the only stressor which had significant associations for every category of exposure for both subscales. The magnitude of associations for subscales were smaller than for total socioemotional difficulties (see Appendix 6, tables A6.1 and A6.2). For example, in final models, exposure to maternal depression in the past and present was associated with 53% and 88% greater odds of externalising and internalising difficulties, respectively, compared to 152% for total socioemotional difficulties.

6.4. 5 Summary

All longitudinal stressors were associated with greater odds of high socioemotional difficulties in unadjusted models. After final adjustments for other stressors, there was no association between LLI and socioemotional difficulties. The association between relationship change and socioemotional difficulties remained robust to full adjustment only for children whose parents had been through a relationship change at age 11. Of the longitudinal stressors, the largest association was seen for the relationship between parent-child conflict and total socioemotional difficulties. In the final model, compared to never being exposed to parent-child conflict, being exposed to present, or past and present conflict was associated with over a fourfold increase in odds of high socioemotional difficulties. Maternal depression was the only longitudinal stressor for which all categories of time of exposure had a significant association with high socioemotional difficulties.

Obesity

6.4. 6 Limiting longstanding illness

In the unadjusted model, children who were exposed to parental LLI in the past and present, compared to those who were never exposed, had 75% higher odds of being obese (95% CI 1.33-2.30).

Table 6. 5 Odds ratios (95% CI) for multivariable logistic regression models showing the associations between longitudinal stressors and obesity at age 11 years

Stressors (N=7,804)	Model 1	Model 2	Model 3	Model 4
Limiting longstanding illness				
Never	Reference category			
Past	1.00	0.83	0.77	0.77
	0.59 - 1.70	0.44 - 1.54	0.41 - 1.47	0.41 - 1.46
Present	0.75	0.65	0.57	0.54
	0.40 - 1.43	0.29 - 1.45	0.26 - 1.26	0.24 - 1.23
Past	1.75***	1.28	1.13	1.08
&Present	1.33 - 2.30	0.97 - 1.71	0.85 - 1.51	0.81 - 1.44
Relationship change				
Never	Reference category			
Past	2.27**	1.99*	1.89*	1.82*
	1.35 - 3.81	1.05 - 3.79	1.02 - 3.40	1.00 - 3.33
Present	1.40	1.35	1.30	1.27
	0.95 - 2.07	0.86 - 2.11	0.83 - 2.03	0.81 - 1.98
Past	1.28	1.15	0.94	0.92
&Present	0.95 - 1.73	0.84 - 1.56	0.68 - 1.29	0.66 - 1.28
Parent-child conflict				
Never	Reference category			
Past	1.37	1.62	1.77	1.68
	0.42 - 4.50	0.49 - 5.37	0.53 - 5.92	0.53 - 5.28
Present	1.10	0.97	1.01	1.03
	0.80 - 1.51	0.68 - 1.39	0.70 - 1.45	0.71 - 1.48
Past	1.18	1.09	1.19	1.17
&Present	0.89 - 1.57	0.81 - 1.47	0.89 - 1.60	0.87 - 1.59
Maternal depression				
Never	Reference category			
Past	1.95	1.92	1.83	1.81
	0.85 - 4.48	0.73 - 5.01	0.69 - 4.83	0.67 - 4.87
Present	2.50**	1.67	1.20	1.20
	1.29 - 4.86	0.95 - 2.94	0.67 - 2.14	0.65 - 2.21
Past	1.98**	1.58	1.26	1.21
&Present	1.29 - 3.03	0.96 - 2.61	0.77 - 2.06	0.75 - 1.97

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Obesity regressed on stressor (limiting longstanding illness; relationship change; parent-child conflict; or maternal depression)
Model 2: Model 1 + cohort member (CM) and maternal characteristics
Model 3: Model 2 + baseline family socioeconomic characteristics
Model 4: Model 3 + other longitudinal stressors

All other categories of exposure to parental LLI failed to reach significance. After controlling for child and maternal characteristics associations were fully attenuated.

Overweight

In support of findings for past and present LLI and obesity, past and present LLI was also associated with 28% greater odds of being overweight in the unadjusted model. There was also a weak association for past exposure with 44% greater odds of being overweight at 11 years, which was unchanged by adjustment for all potential confounders (95% CI 1.07 – 1.93, Appendix 6, Table A6.3)

6.4. 7 Relationship change

In the unadjusted model, for children who were exposed to past parental relationship change (one or more relationship changes between 9 months and 7 years), compared to children whose parent remained in the same relationship, there was over a twofold higher odds of obesity (OR 2.27, 95% CI 1.35 - 3.81). After statistical adjustment for child and maternal characteristics the association remained (table 6.5). In model 3, the association remained robust to additional adjustment for family SEP (OR 1.89, 95% CI 1.02-3.40). In the final model, the association fell just short of statistical significance as the confidence interval includes 1 (95% CI 1.00-3.33), indicating that the association may have been explained by other psychosocial stressors.

Overweight

In addition, past and present relationship change was associated with 24% greater odds of being overweight. This association remained unchanged by adjustment for cm and maternal characteristics but fell short of statistical significance after additional adjustment for family socioeconomic characteristics (Appendix 6, Table A6.3).

6.4. 8 Parent-child conflict

Parent-child conflict was not associated with obesity, or overweight, at age 11 at any level of adjustment (see Table 6.5).

6.4. 9 Maternal depression

In the unadjusted model, compared to children whose mothers never scored high on the Kessler scale across the four sweeps, exposure to maternal depression in the present (OR 2.50, 95% CI 1.29 - 4.86), and the past and present sweeps (OR 1.98, 95% CI 1.29 - 3.03) was associated with greater odds of obesity for children. After adjustment for child and maternal characteristics, these associations were fully attenuated (table 6.5). These findings were replicated in sensitivity analysis. Maternal depression was not associated with being overweight at 11 years at any level of adjustment (Appendix 6, Table A6.3).

6.4. 10 Summary

In the analysis of longitudinal stressors and obesity, associations for both LLI and maternal depression with obesity were fully attenuated by child and maternal characteristics. Parent-child conflict had no association with obesity at age 11 in any model. The association between past relationship change and obesity remained robust to adjustment for maternal characteristics and family SEP, however, the association just fell short of statistical significance after adjustment for other stressors (LLI, parent-child conflict and maternal depression).

6.5 Discussion

6.5. 1 Summary of results

With regards to children's socioemotional difficulties, all stressors were initially associated with greater odds of experiencing high socioemotional difficulties. After the final model of adjustment, which controlled for other stressors, there was no association between LLI and total socioemotional difficulty scores, although associations with relationship change, parent-child conflict and maternal depression, remained significant. There was no association found for past parental relationship change or parent-child conflict and socioemotional difficulties; only present, or past and present exposure remained robust to adjustment. In support of the conceptual framework presented in chapter 3, the largest associations between stressors and socioemotional difficulties were observed for the most proximal stressors to children's day-to-day experiences; parent-child conflict, followed by maternal depression. Maternal depression was the only stressor of which all categories of exposure had significant associations with socioemotional difficulties. The largest associations were seen for present exposure, suggesting contemporaneous effects had the greatest impact on children's behaviour.

Children's obesity was positively associated with exposure to LLI and maternal depression, but associations for both stressors were fully attenuated by child and maternal characteristics. Parent-child conflict had no association with obesity. Relationship change was the only stressor for which the association with obesity was not fully explained by child and maternal characteristics and family SEP. However, the association between past relationship change and obesity just fell short of significance in the final model after adjustment for other stressors (LLI, parent-child conflict, maternal depression).

Recalling the hypotheses in chapter 3 regarding the analysis of longitudinal pathways from psychosocial stressors at repeated time points in childhood, the first (Hypothesis 2.1) was that exposure to stressors earlier in childhood would be associated with

greater odds of having high socioemotional difficulty scores and obesity in pre-adolescence. There was little evidence to support hypothesis 2.1 for socioemotional difficulties and obesity. The second hypothesis (Hypothesis 2.2) was that compared to experiencing stressors in the past (ages 3, 5, or 7) or present (age 11) only, exposure to stressors at a past time point and at age 11 years would have a larger association with socioemotional difficulties and obesity. However, estimates for present, and for past and present exposure to parent-child conflict and maternal depression overlapped, indicating little support for hypothesis 2.2.

6.5. 2 Comparison to literature

Socioemotional difficulties

There has been little analysis of the association between parental LLI generally, and children's health, with studies normally focusing on specific chronic health conditions (Sieh et al., 2010). However, the findings here that children whose parents have a LLI are more likely to have socioemotional difficulties is supported by a previous paper using MCS by Kelly and colleagues (2010), which found children whose main carer had poor health were more than four times as likely to have high socioemotional difficulties at age five years than children whose carers were in the best health group.

The lack of a robust longitudinal association between relationship change and children's mental health could be explained by reduced stigmatisation surrounding divorce in recent years, and the increase in support for children and parents making it a less disruptive event for children (Emery, 1999). Another reason could be that the measure captures any relationship change, whether that is the dissolution of a relationship or the coming together of a new relationship. A new partner coming into the household may result in a period of disruption for children, but it may also bring with it positive features such as more financial security and increased assets. A study examining changes in family structure using MCS data found that coupled parents who separate suffer the largest drop in income over five years and single-parents who

partner gain the most income (Panico et al., 2010). Children in households with higher incomes are less likely to have socioemotional difficulties (Kelly et al., 2011).

The current study found evidence of an association between parent-child conflict and children's socioemotional difficulties. This is strongly supported by existing studies, with the effects of parent-child conflict widely understood to have damaging effects on children's mental health, across varied populations (Heilmann et al., 2015, Miller et al., 2000, Halliday et al., 2014). However, this analysis found no longitudinal association between parent-child conflict and children's socioemotional difficulties after adjustment for confounding factors, which differs from other findings that have found lasting associations into adulthood (Afifi et al., 2013, Afifi et al., 2012).

The was very little evidence of accumulation of risk throughout the analysis, for example, only parental relationship change in the present sweep was associated with socioemotional difficulties after final adjustment. Similarly, the estimates for present exposure to maternal depression and parent-child conflict overlapped with that for past and present exposure, indicating no further detrimental association for being exposed at multiple time points. One concept which offers an explanation for this is hedonic adaption theory, also known as the hedonic treadmill model, which posits that humans tend to quickly return to a set point of emotional well-being, which vary considerably across individuals, following significant positive or negative life events (Diener et al., 2006). Brickman and Campbell (1971) suggest that an individual's emotional system will adjust to their current life circumstances and that all reactions are relative to prior experiences (Brickman and Campbell, 1971). This may explain the lack of longitudinal association between past relationship change and LLI with socioemotional difficulties and the absence of additional detrimental effects for being exposed to maternal depression and parent-child conflict multiple time points.

Differences for associations between past and, past and present parent-child conflict may also be partially explained by the difference in measurement of parent-child conflict at age 11. As the Conflict Tactics scale was not available at age 11, a question

on whether or not parents have frequent battles with children was used as the measure of parent-child conflict.

With respect to findings for socioemotional difficulties subscales, studies have often found that the greatest associations have been between parent-child conflict and externalising difficulties (Marmorstein and Iacono, 2004, Burt et al., 2003, Burt et al., 2005). Using a sample consisting of 808 same-sex twins, a study in the US found that the longitudinal association between parent-child conflict at age 11 and externalising behaviour at age 14 was mediated by both genetic inheritability and the shared psychosocial environment (Burt et al., 2003). Parent-child conflict was found to act as a risk factor for multiple childhood disorders including attention-deficit/hyperactivity disorder (ADHD), oppositional defiant disorder (ODD), and conduct disorder, supporting the findings of the current research.

Maternal depression was the only stressor, for which all categories of exposure had significant associations with children's socioemotional difficulties. Results have shown that exposure to maternal depression at any stage of childhood can have detrimental effects on children's socioemotional difficulties. The effects of maternal depression on children's socioemotional difficulties are considered in the literature to operate through the social interactions within the family context, with the home environment for children whose mothers have depression characterised as lacking in stimulation and social support (Kaplan et al., 2009, Cummings and Davies, 1994). There are also many social and economic factors associated with risk of maternal depression (Barker et al., 2012, Reading and Reynolds, 2001, Panico et al., 2014), along with an increased risk of inherent characteristics passed from mother to child. Associations remained robust to adjustment to child and maternal characteristics, family socioeconomic factors and other possible psychosocial stressors. The association between maternal depression and children's socioemotional difficulties was minimally explained by factors included in the analysis, therefore there is likely to be a mechanism between maternal depression and children's socioemotional difficulties, possibly through parenting behaviours and

family functioning as the literature suggests (Ashman et al., 2008, Kaplan et al., 2009, Cummings and Davies, 1994), that was not explained by the analysis. Similarly to the findings of this thesis, using ALSPAC data, Barker and colleagues (2012) found that longitudinal associations of externalising and internalising behaviours with exposure to maternal depression remained significant, independent of cumulative risk.

Obesity

The finding of an increased risk of obesity amongst children whose parents have an LLI is consistent with a previous study by Kelly and colleagues (2010), which also used the MCS. They found a positive association between exposure to poor parental self-rated health and childhood obesity, which was mostly explained by family health behaviours and social disadvantage.

Previous analyses of the association between maternal depression and childhood obesity have been inconclusive. For example, Lampard and colleagues (2014) conducted a systematic review of prospective studies which looked at the relationship between chronic maternal depression and childhood obesity; they reported that just under half of the studies (n=4) found no association.

There was no association between parent-child conflict and childhood obesity. This study adds to the literature as very few studies have examined the longitudinal association between parent-child conflict and childhood obesity in a UK context (Halliday et al., 2014). Studies that have found associations between parent-child conflict and childhood obesity have been cross-sectional, with small sample sizes that controlled for a limited number of confounding factors (Hooper et al., 2009, Hanson et al., 1990).

Relationship change was the only longitudinal stressor to be associated with obesity after accounting for child and maternal characteristics and family SEP. There is a lack of studies which have looked at the connection between parental relationship change and childhood obesity. One reason for the association of parental relationship change

with children's health could be the economic gap between children with single-parents and children with married parents (Burtless, 1999), that combined with other factors related to relationship breakdown, such as the psychological health of parents and family dysfunction, could result in a home environment that enables weight gain.

6.5. 3 Strengths and limitations

For each of the psychosocial stressors (limiting longstanding illness (LLI), relationship change, parent-child conflict; or maternal depression), a variable was created to capture how exposure might be categorised over time. Data from all four time points (3, 5, 7, and 11 years) were used to generate four categories of exposure: never , past (at age 3, and/or 5, and/or 7 years of age), present (at age 11 a single), past and present (at age 3, and/or 5, and/or 7, and at age 11 years of age).

Much of the existing literature on psychosocial stressors and childhood outcomes uses a composite score measure (Appleyard et al., 2005). The categorisation of exposure to stressors used in this analysis adds to the literature by distinguishing estimates of associations between four stressors, socioemotional difficulties and obesity for children who were exposed at multiple time points across the first decade of life. Originally a fourth category was exposure to the stressor at every data collection sweep, but there were too few cohort members categorised as such for analysis.

Previous research has often grouped psychosocial, economic and physical stressors together (Appleyard et al., 2005, Trentacosta et al., 2008), which as discussed in the literature review chapter, is a frequent problem concerning accumulation of risk studies (Bartley, 2017). A strength of this study is that it examines varied, individual psychosocial stressors, independent of each other. The analysis gives a better understanding of which psychosocial stressors have the strongest relationships with children's mental and physical health.

Descriptive analysis was performed on the missing data to examine the difference between the final sample and the people with missing data. Children who had missing

data on stressors were more likely to be exposed to other stressors and have a disadvantaged socioeconomic position, therefore it's possible that analysis may underestimate the associations of stressors with socioemotional difficulties and obesity, however, all analysis was performed using weights which adjust for survey design and loss to follow-up.

To further understand the pathways from exposure to psychosocial stressors and children's socioemotional difficulties and obesity the next chapter looks at the possible moderating effects of family structure and health behaviours.

Chapter 7: Analysis of potential moderating health behaviours and family structure

This chapter examines the potential moderating effects of health behaviours and family structure on the relationship between stressors in the home environment and socioemotional difficulties and obesity in pre-adolescents (age 11 years). The first hypothesis is that associations between stressors and children's health outcomes will be smaller for children who have healthier lifestyles. Healthier lifestyles include more physical activity, regular bedtimes and less time engaging in sedentary activities such as watching television. The second hypothesis is that the associations between stressors and health outcomes will be smaller for children in two-parent families and for children with fewer siblings to compete with for parental resources. First, the measures of health behaviours and family structure which were used are explained. Then findings from likelihood ratio tests are presented and results are discussed within the wider context of the existing literature.

7.1 Methods

Four health behaviours at age 11 pertaining to physical activity, sedentary behaviour and sleep were identified in MCS. They are bedtimes; physical activity; whether the child has a television in their bedroom and how much time children spend watching television. Each health behaviour is summarised in table 7.1.

Respondents were asked, *on weekdays during term-time, does the cohort child go to bed at a regular time?* If parents answered yes, interviewers probed, *is that sometimes, usually or always?* The four original categories of never, sometimes, usually and always were collapsed down to 0 always and usually versus 1 sometimes and never in order to compare the difference between children who did not have a regular bedtime compared to those who did. Ninety-one per cent of children either always or usually had a regular bedtime at age 11 (see table 7.1).

Respondents were asked, *how many days a week does the cohort child usually go to a club or class to do sport or any other physical activity like swimming, gymnastics, football, dancing etc?* Answers were coded in a 7 category variable which ranged from 1, five or more days to 7, not at all. This was collapsed into a binary variable to compare children who were 0, 5 days or more doing physical activity, (a marker closest to meeting government guidelines of 60 minutes of vigorous activity every day), compared to 1, children who were physically active for 4 days or less. Forty-eight per cent of children were doing organised physical activity or sports on 5 days a week or more at age 11.

Respondents were asked if children had a television in his/her bedroom which was coded as 0 no or 1 yes. Sixty per cent of children had a television in their bedroom at age 11.

Respondents were asked, *on a normal weekday during term time, how many hours does the child spend watching television programmes or films, including time spent watching programmes or films on a computer or mobile device?* Hours were categorised as 1, none; 2, less than an hour; 3, 1 hour to less than 2 hours; 4, 2 hours to less than 3 hours; 5, 3 hours to less than 5 hours; 6, 5 hours to less than 7 hours or 7, hours or more. For moderation analysis time spent watching television (TV) was kept as a continuous variable. Compared to physical activity, there is no meaningful guideline for the number of hours of television children watch, therefore hours of television viewing was left as a continuous variable. The mean amount of time children spent watching television on a normal weekday was 3.5 hours at age 11.

Two measures of family structure were identified at age 11; parental relationship status and the number of siblings children had. Too few children had resident step-siblings (<1%) for analysis of blended families to be possible.

Parental relationship status was captured in a 3 category variable, consisting of 0, married; 1, cohabiting; 2, single-parents. To analyse the difference between two-parent

families and single-parent families, parental relationship status was recoded as 0, married or cohabiting and 1, single-parent. At age 11, just under 80% of respondents were married (60%) or cohabiting (19%) and 22% were single-parents.

Respondents were asked how many siblings of cohort members lived in the household. Answers were categorised as 0, 1, 2, or 3 or more. The majority of the sample, 75%, had 1 or 2 siblings.

7.2. Analytical approach

The distribution of socioemotional difficulties and obesity by health behaviours and family structures were examined. The moderating effects of health behaviours and family structure were tested for by including interaction terms in fully adjusted regression models. Likelihood ratio tests were performed to test if the inclusion of interaction terms made a significant difference. A Bonferroni correction (p-value 0.05/number of tests=6) was used to counteract the problem of multiple testing. As multiple testing increases the possibility of a significant result by chance, only p-values <0.008 were considered significant. To account for small numbers in categories of exposure in moderation analysis, each stressor was recategorised as 0 never exposed, and 1 exposed once or more.

7.3. Results

Children with irregular bedtimes, who did less physical activity and watched more television were more likely to have high socioemotional difficulties and be obese. Children in single-parent families were more likely to have high socioemotional difficulties and more likely to be obese. Children with no siblings had a greater proportion of high socioemotional difficulties and obesity (refer to table 7.1).

The distribution of health behaviours by stressors is examined in Table 7.2. Children whose parents had a LLI at any time point, whose parents had been through a relationship change at least once or had a mother with depressive symptoms were more likely to have a television in their room, spend more time watching television and

have a single-parent. Children whose parents had been through a relationship change at least once were also more likely to have no siblings. The only potential moderator which was associated with parent-child conflict was bedtimes, with children who were exposed to parent-child conflict at any time point less likely to have regular bedtimes.

Table 7. 1 Distribution (weighted %) of high socioemotional difficulties and obesity by health behaviours

Health behaviours & family structure	Prevalence % (N=7,791)	High socioemotional difficulties (N=7,791) %	p-value*	Obesity (N=7,005) %	p-value
Regular Bedtimes					
Always & Usually	90.6	8.0		5.4	
Sometimes & Never	9.4	14.7	<0.001	7.8	0.0301
Physical Activity					
5/>5 days a week	48.1	7.4		4.6	
4/<4 days a week	51.8	9.8	0.0039	6.6	0.0072
Whether TV in bedroom					
No	39.5	6.0		3.9	
Yes	60.4	10.4	<0.001	6.7	0.0003
Time spent watching TV					
None to <2 hours	59.6	7.2		4.5	
2 to 7 hours	40.4	10.9	<0.001	7.4	<0.001
Parental relationship status					
Married or cohabiting	78.0	7.3		4.8	
Single-parent	22.0	13.4	<0.001	8.6	<0.001
No. of siblings in HH					
0	11.8	11.3		9.3	
1 or more	88.2	8.3	0.0105	5.2	<0.001

*p-value for the association between health behaviours and children's outcomes, using chi-squared test

Table 7. 2 Distribution (weighted %) of health behaviours by stressors

Health behaviours & family structure	LLI %	p-value*	Relationship change %	p-value	Parent-child conflict %	p-value	Maternal depression %	p-value
Regular Bedtimes								
Always & Usually	38.9		31.4		56.4		9.7	
Sometimes & Never	42.7	0.0922	32.6	0.6222	66.7	<0.001	18.8	<0.001
Physical Activity								
5/>5 days a week	40.4		32.1		57.9		10.2	
4/<4 days a week	38.2	0.0894	30.9	0.3462	56.9	0.4103	10.8	0.4815
Whether TV in bedroom								
No	36.0		22.4		56.4		8.1	
Yes	41.4	<0.001	37.4	<0.001	58.0	0.2291	12.1	<0.001
Time spent watching TV								
None to <2 hours	37.7		30.4		56.7		8.9	
2 to 7 hours	41.5	0.0034	33.1	0.0436	58.4	0.2113	13.0	<0.001
Parental relationship status								
Married or cohabiting	38.2		19.1		57.5		8.0	
Single-parent	43.0	0.0047	75.4	<0.001	57.1	0.8047	19.5	<0.001
No. of siblings in HH								
0	41.7		38.6		57.6		11.5	
1 or more	38.9	0.1947	30.5	<0.001	57.4	0.9238	10.4	0.3937

*p-value for the association between health behaviours and stressors, using chi-squared test

Table 7. 3 Chi-squared statistic and p-values for likelihood ratio tests for interactions between longitudinal stressors and health behaviours

	Socioemotional difficulties sample (N=7,791)		Obesity sample (N=7,005)	
Health behaviours	χ2	p-value	χ2	p-value
Regular Bedtimes				
LLI	064	0.42	0.72	0.39
Relationship change	2.01	0.15	0.07	0.79
Parent-child conflict	1.47	0.22	0.20	0.65
Maternal depression	1.71	0.19	0.97	0.32
Physical Activity				
LLI	0.71	0.40	0.03	0.86
Relationship change	2.97	0.08	0.29	0.58
Parent-child conflict	0.77	0.37	5.95	0.31
Maternal depression	1.33	0.24	0.05	0.82
Whether TV in bedroom				
LLI	3.41	0.06	0.80	0.37
Relationship change	1.96	0.16	1.71	0.19
Parent-child conflict	0.02	0.87	0.73	0.39
Maternal depression	0.50	0.47	0.52	0.47
Time spent watching TV				
LLI	0.46	0.49	0.27	0.60
Relationship change	1.17	0.27	1.51	0.21
Parent-child conflict	0.34	0.56	0.91	0.34
Maternal depression	0.82	0.36	2.52	0.11
Parental relationship status				
LLI	0.04	0.84	0.01	0.90
Relationship change	5.34	0.02	0.01	0.93
Parent-child conflict	12.06	<0.001	0.19	0.66
Maternal depression	2.22	0.13	0.70	0.40
Number of siblings				
LLI	0.23	0.62	0.66	0.41
Relationship change	2.07	0.15	2.07	0.15
Parent-child conflict	0.14	0.71	0.17	0.68
Maternal depression	0.90	0.34	0.83	0.36

The p-value statistics in table 7.3 show that none of the health behaviours were significant moderators of the relationship between stressors and socioemotional difficulties and obesity. Number of siblings was not a significant moderator of the associations between longitudinal stressors, socioemotional difficulties and obesity.

A significant interaction was found between parent-child conflict and parental relationship status for socioemotional difficulties as the outcome. Multivariable regressions stratified by parental relationship status are shown in table 7.4. Children who were exposed to any parent-child conflict up to age 11 were more likely to have socioemotional difficulties at 11 years of age if they were in single-parent households than if they were in two-parent households (OR: 12.02, 95% CI 6.73 – 21.61).

Table 7. 4 Fully adjusted odds ratios (95% CI) for multivariable logistic regression models showing the association of socioemotional difficulties and parent-child conflict by family structure (N=7,791)

Family structure	Fully adjusted model	
Married or cohabiting parents		
No conflict	Reference category	
Any conflict	3.30***	2.46-4.42
Observations	6,201	
Single-parents		
No conflict	Reference category	
Any conflict	12.02***	6.73 – 21.61
Observations	1,590	

*** p<0.001, ** p<0.01, * p<0.05

Models adjust for cohort member, maternal and family characteristics, LLI, relationship change and maternal depression

7.4. Discussion

7.4. 1 Summary of results

There was no evidence of moderation of associations between stressors and outcomes by health behaviours. There was also no interaction between the number of siblings in the family and stressors affecting socioemotional difficulties or obesity. The first hypothesis, hypothesis 3.1 in chapter 3, was that associations between stressors and children's health outcomes would be smaller for children who had healthier lifestyles. This was observed descriptively in table 7.1., even though there was no support for effect modification informal tests.

The second hypothesis, hypothesis 3.2 in chapter 3, was that the associations between stressors and health outcomes would be smaller for children in two-parent families and for children with fewer siblings to compete with for parental resources. There was no evidence that having fewer siblings was protective for children's health, but children who were exposed to parent-child conflict at any time-point had more socioemotional difficulties if they were in single-parent families than in two-parent families.

7.4. 2 Comparison to literature

Sleep has been consistently associated with children's socioemotional difficulties and obesity (Lumeng et al., 2007, Kelly et al., 2013b, Kelly et al., 2016). There is evidence to support the idea that in households characterised by high levels of stressors, family functioning and routines may be negatively affected, with children having irregular sleep (Trentacosta et al., 2008, Lemola et al., 2012). Despite this, no evidence of moderation by bedtimes was found. One reason for this could be that adjustment for other stressors accounts for some aspects of disrupted lifestyles and family routines.

For both outcomes there was no evidence to support moderating effects of physical activity, lending little support to the government recommendation of physical activity for at least 60 minutes every day (Chief Medical Office, 2011). Many reviews have found regular physical activity can act as a protective factor for mental health (Biddle and

Asare, 2011) and physical health (Pietilainen et al., 2008), but formal tests in this analysis do not demonstrate evidence for moderation of associations for stressors with socioemotional difficulties and obesity by physical activity.

Television viewing is the most prevalent sedentary behaviour for young people in industrialised countries (Marshall et al., 2006). Electronic screen time entertainment has been associated with socioemotional difficulties, obesity, disrupted sleep and lower cognitive scores in childhood (Mistry et al., 2007, Pagani et al., 2010, Burdette and Whitaker, 2005, Cain and Gradisar, 2010, Heilmann et al., 2017, Booker et al., 2015). Parkes and colleagues (2014) found watching television for more than 3 hours at 5 years predicted a 0.13 point increase in conduct problems by 7 years, compared to watching for under an hour. In addition to the detrimental effects of watching television on children's socioemotional difficulties, a study using the MCS found having a television in the bedroom at age 7 years was associated with significantly higher BMI and fat mass index at age 11 years (Heilmann et al., 2017). Despite associations in the literature for television usage and children's health, this study found no evidence of effect modification by hours spent watching television or by whether children had a television in their bedroom.

Opposed to the conceptual framework, there was little evidence found to suggest that the effect of stressors is moderated by health behaviours. However, as multiple health behaviours were associated with both stressors and health outcomes, they may be on the causal pathway between stressors with socioemotional difficulties and obesity, exerting risk or protective effects themselves. For example, children exposed to maternal depression were more likely to watch television which might exacerbate the effects of maternal depression on children's risk of obesity.

An interaction for parental relationship status and parent-child conflict was found for socioemotional difficulties. It might be that if children are frequently having arguments with a parent, having another parent that they are emotionally close to and feel supported by is beneficial to their socioemotional well-being. Studies have consistently

found that children in single-parent households are at greater risk of disadvantaged socioeconomic position, maternal depression and parent-child conflict (Laursen, 2005, Panico et al., 2010, Hansen and Joshi, 2008). Although the analysis has statistically controlled for these factors there might still be some residual confounding.

7.4. 3 Strengths and limitations

Findings show a possible protective effect of being in a two-parent household against the detrimental effect of parent-child conflict on children's mental health. The confidence interval is wide which indicates that the estimate may be imprecise (CI 4.38-22.92). One reason for this is that there were only 1,593 children in single-parent families; with a larger sample, a more precise estimate would be expected. If there was more detailed information on children's relationships it might have been possible to isolate the significant factors of parent-child relationships which moderate the effects of conflict on children's mental health and understand what exactly it is about single-parent families that increase children's risk of socioemotional difficulties due to parent-child conflict.

Unfortunately, I was unable to fully measure the complexity of relationships between parents and children and was limited to the data already available in the MCS. For example, parent-child conflict at 11 years was based on a question to parents about whether they had frequent battles with their children and there was no detail available on the severity or frequency of arguments. As outlined in the theoretical underpinning section of the literature, interactions in the microsystem are not one-sided, with the personal characteristics of caregivers, family members and teachers having reciprocal influences on children. There are also substantial impacts of other social institutions outside the family, such as school and peer groups. Therefore, it is impossible to fully observe children's day-to-day environments.

A strength of the study is that, as the MCS is such a rich dataset, multiple health behaviours and family structures could be examined, showing that formal tests for interactions did not lend support to the protective effects of healthy behaviours. It is

difficult to measure health behaviours, as one measure often does not necessarily capture all possible lifestyle factors. For example, the measure of physical activity might not fully capture children's physical activity, as it does not capture how active the children are when at they're doing physical activity or informal activity. More rigorous measures of health behaviours are needed for further analyses.

To further understand the relationship between psychosocial stressors, socioemotional difficulties and obesity, the next chapter examines the longitudinal pathways between obesity and socioemotional difficulty scores at multiple time points during childhood using a cross-lagged model.

Chapter 8: Analysis of the longitudinal pathways between obesity and socioemotional difficulty scores

Previous chapters have examined associations between psychosocial stressors and both, socioemotional difficulties and obesity. Now, the longitudinal relationship between socioemotional difficulties and obesity is analysed. A previous study existing in the literature that used MCS (Griffiths et al., 2011), found cross-sectional associations between socioemotional difficulties and BMI at ages 3 and 5 years. To add to the knowledge base on the relationship between mental health and weight status during childhood and pre-adolescence, the final objective of this thesis is to examine the longitudinal patterning of socioemotional difficulty scores and BMI at multiple time points during childhood. To better understand the directionality of associations, path analysis will be used.

There are two hypotheses for the final objective: first, the association between having a higher BMI earlier in childhood to having higher socioemotional difficulties at older ages will be larger than for the opposite direction (socioemotional difficulties to BMI); and second, the association between BMI and socioemotional difficulties will be partially explained by psychosocial stressors. As previous chapters have shown children are more likely to have socioemotional difficulties and be obese in households characterised by psychosocial stressors, psychosocial stressors are treated as potential confounders of the relationship between socioemotional difficulties and BMI. This chapter will first explain the cross-lagged structural equation model (SEM) used to examine BMI and socioemotional difficulties across multiple time points, then it will outline the results, and finally, compare the findings with the existing literature and discuss the strengths and limitations of the analysis.

8.2 Analytical sample

Figure 8.1 depicts how the analytical sample was derived for the longitudinal BMI and socioemotional difficulties analysis. After excluding children born in multiple births (n=175) there were 6,404 with complete information on BMI, socioemotional difficulties, stressors and confounders. A likelihood ratio test showed a significant puberty by sex interaction for the association between socioemotional difficulties and BMI, therefore all analyses were stratified by sex (n=3,247 girls and n=3,157 boys).

The default estimation option for the SEM command in Stata omits observations that contain missing values in observed variables used in the model. However, by specifying full information maximum likelihood, the estimation adjusts the likelihood function so that each case contributes information on the observed variables (Acock, 2015).

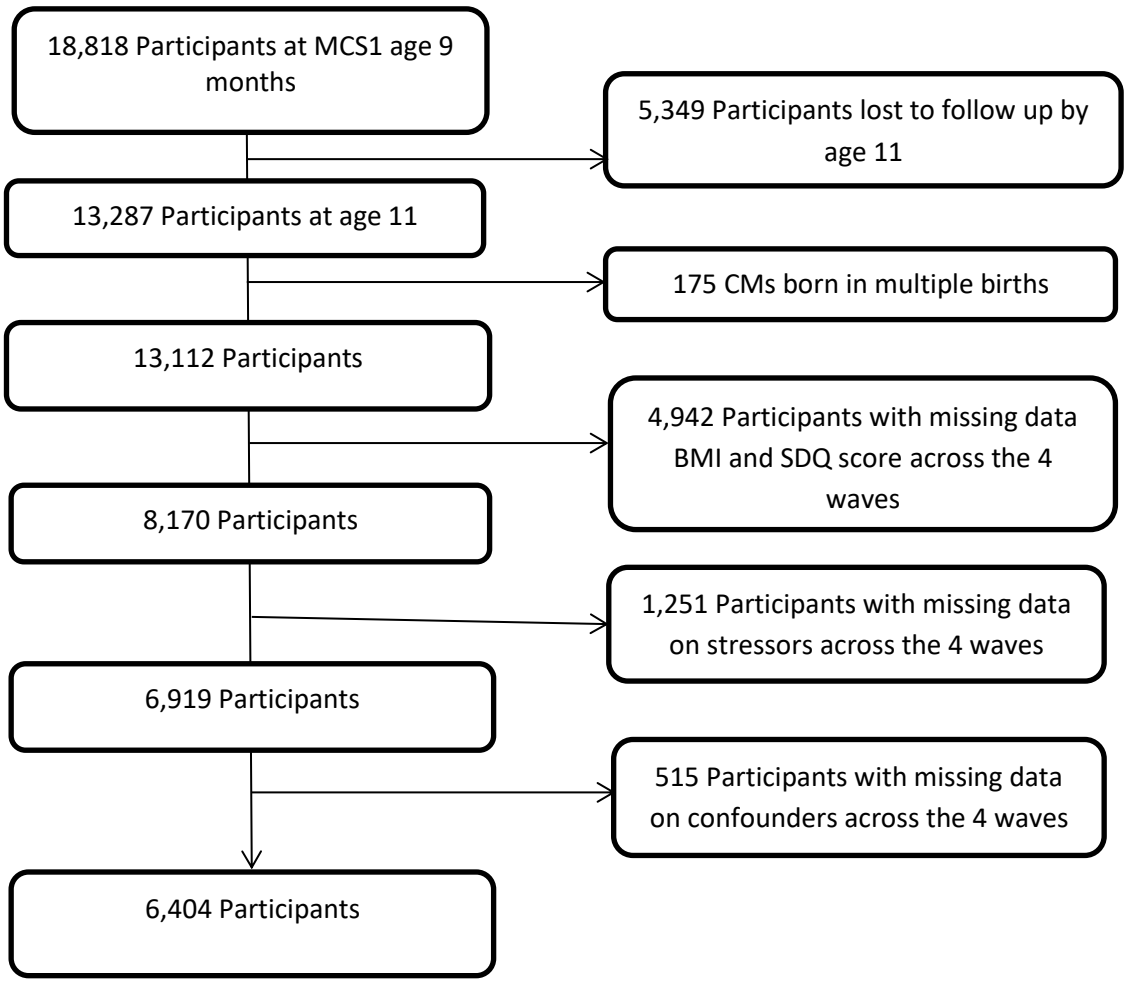

Figure 8. 1 Longitudinal BMI and socioemotional difficulties analysis sample

To understand whether sample attrition had impacted estimates, models were first run using complete case analysis, then compared to results for analyses conducted using full information maximum likelihood analysis (FIML). For consistency, as complete case analysis was used throughout previous empirical chapters, FIML was utilized as a supplementary analysis. For models using FIML, there were 6,477 girls and 6,635 boys.

8.1. Analytical approach

Data on BMI and socioemotional difficulties from all four time points (3, 5, 7, and 11 years) were used to construct a cross-lagged model. Due to the timing of MCS data collection sweeps, there are 2-year lags between measures collected at each of the first three time points, at ages 3, 5, and 7 years. Then data were collected four years later, at age 11 years. Models were built using the SEM command in Stata 15. Informed by existing literature and likelihood ratio tests for interactions between sex and pubertal status, models were stratified by sex. All models for complete case analyses employed longitudinal weights for sample design and response rates. Paths were estimated, in both directions, between socioemotional difficulties and BMI from one time point to the next. Figure 8.2 illustrates this is in further detail. To directly compare paths, standardised coefficients are presented. Unstandardized coefficients are additionally presented in tables 8.2 – 8.5.

The model fit statistics helped select the most appropriate model. The goodness of fit statistics used were the chi-square goodness of fit statistic, the comparative fit index (CFI) and the root mean square error of approximation (RMSEA). Following guidance on model fit statistics (Acock, 2015), I aimed for models to have an RMSEA <0.05, the chi-squared to be small and not significant and for the CFI to be >0.95. However, in studies with large sample sizes the chi-squared statistic is almost always statistically significant making it a less reliable measure of model fit than the CFI or RMSEA.

Initially, a partially adjusted model was executed which adjusted for CM, maternal and family characteristics, but not psychosocial stressors. The cross-lagged SEM model was adjusted at each age for time-invariant covariates (maternal age at birth; maternal smoking status; maternal pre-pregnancy BMI) and cross-sectional measures of time variant measures (income; occupational class; and parental education collected at each sweep) found to be associated with socioemotional difficulties and obesity in previous chapters. Paths were added from covariates to each of the outcomes at every time point.

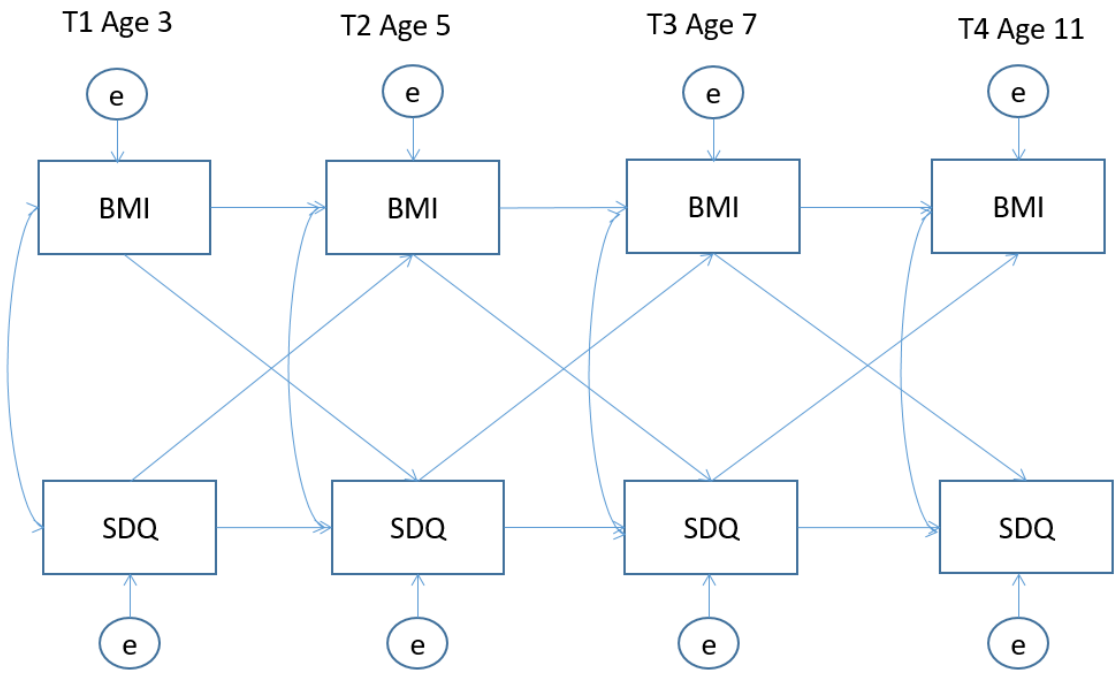

Figure 8. 2 Longitudinal cross-lagged effects model of BMI and socioemotional difficulties.

To improve the model fit, the modification indices command in SEM suggests additional paths to include in the model. Paths were only added if they were supported by theory, substantive analysis and were conceivable given temporality (e.g. did not consider income at 11 years to socioemotional difficulties at 3 years). The plausible paths suggested were: occupational status, income and highest parental education at time 1 (3 years) to BMI at times 3 and 4 (7 years and 11 years); highest parental education and family income at time 3 to BMI at time 4, and family income at time 1 to

SDQ score at time 2 (5 years). To construct the most parsimonious model, manual stepwise backward elimination was employed. Paths from covariates to the outcomes that were non-significant at the 90% level were removed (as the 95% level was deemed too strict for covariates (Grace-Martin, 2018)), checking at each stage that model fit was not poorer. After this process only one of the pathways recommended by the modification indices survived multivariate adjustment and remained in the model; income at time 1 (age 3 years) to BMI at time 4 (age 11 years). Figure 8.3 illustrates this further, showing the confounder adjustment for the partially adjusted model. For this partially adjusted model, there was good model fit with the RMSEA 0.020 (95% CI 0.018 – 0.023) and the CFI 0.992. The chi-squared statistic was 455.828 (d.f. 182) and significant ($p<0.001$).

To understand if psychosocial stressors would further explain the patterning of BMI and socioemotional difficulties, the final model additionally adjusted for psychosocial stressors at each age (limiting longstanding illness; relationship change; parent-child conflict; and maternal depression). Again, to improve the model fit, the modification indices command in SEM suggested additional paths. The paths suggested were: LLI at 3 years to socioemotional difficulties at 7 years; maternal depression at 7 years and BMI at 11 years and parent-child conflict at 7 years to BMI at 11 years. These paths were added, then using stepwise backward elimination, paths from stressors to the outcomes that were non-significant at the 90% level were removed, checking at each stage that model fit was not poorer. After this process, the additional paths remaining were for LLI at 3 years to socioemotional difficulties at 7 years and maternal depression at 7 years and BMI at 11 years. Figure 8.4 illustrates this further.

There was a good model fit for the final model, with the RMSEA 0.029 (95% CI 0.027 – 0.031) and the CFI 0.969. The chi-squared statistic was 1312.097 (d.f. 358) and significant ($p<0.001$). It should be noted that despite the terminology in the following results section describing paths, it is not my intention to assume causality.

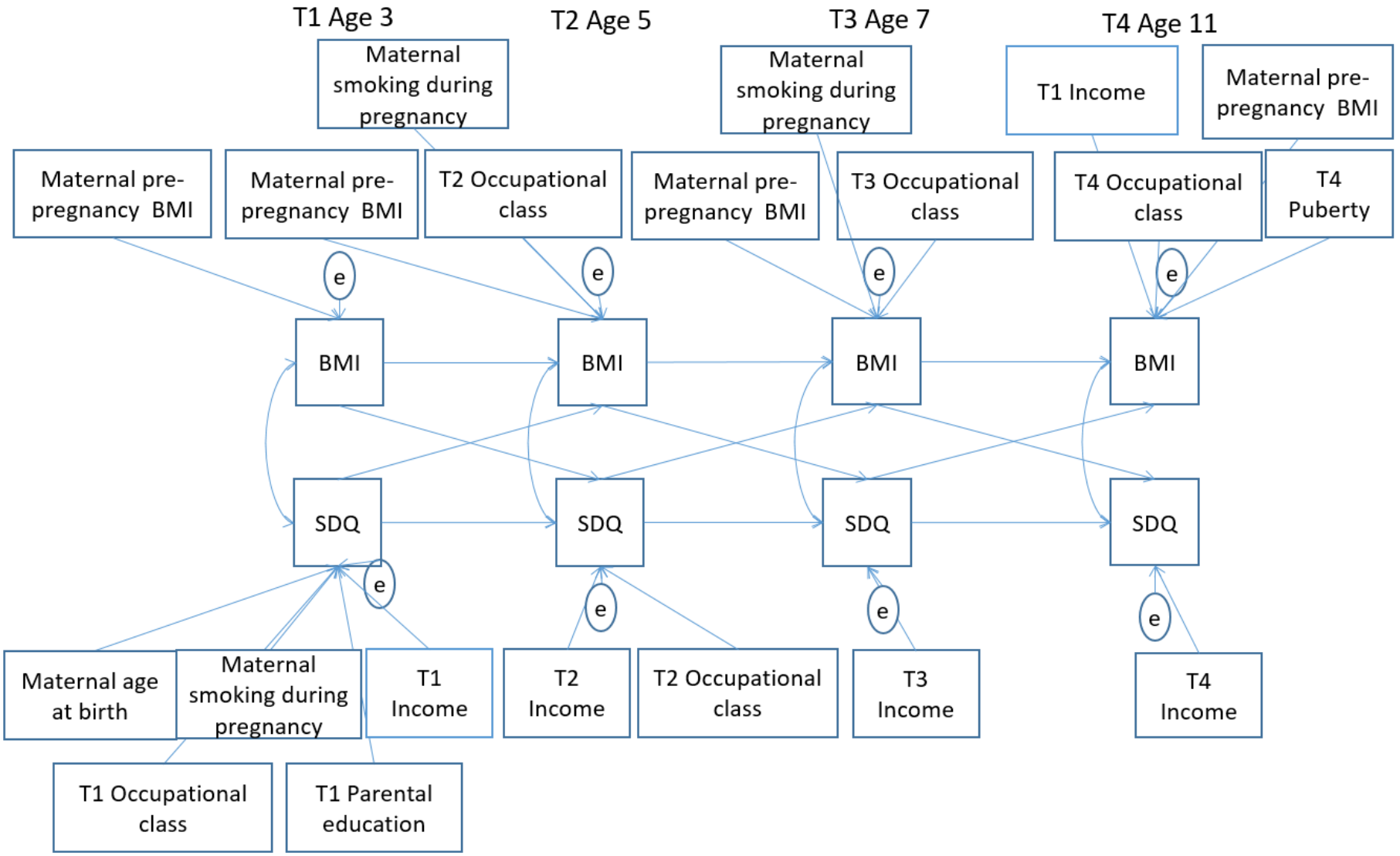

Figure 8. 3 Longitudinal cross-lagged effects model of BMI and socioemotional difficulties, including paths for covariates

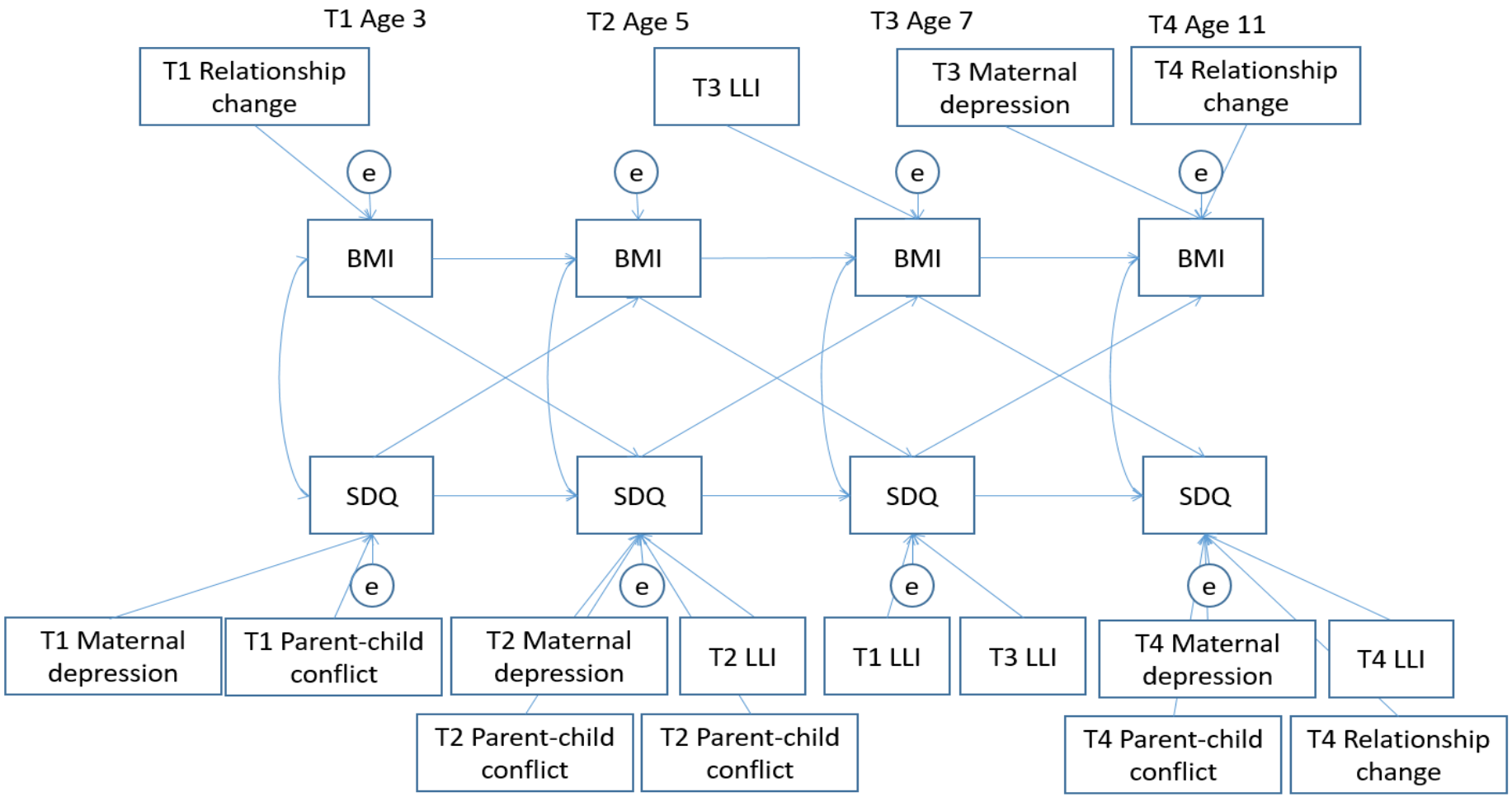

Figure 8. 4 Longitudinal cross-lagged effects model of BMI and socioemotional difficulties, including paths for psychosocial stressors

*Model also includes covariates in Figure 8.3

8.2 Cross-lagged SEM results

Table 8.1 presents all weighted correlations between BMI and socioemotional difficulties at the four time points for boys and girls separately. First, stability coefficients were high for BMI for both males and females; similarly, reports of socioemotional difficulties were fairly stable over time. Second, for girls and boys there were small, yet systematic, within-time correlations between BMI and socioemotional difficulties; for girls, the within-time correlation between BMI and socioemotional difficulties at age 11 was over twice that at other ages (r=0.12, p<0.0001). Further for both males and females, there were across-time correlations between BMI at ages 5 and 7, and subsequent increases in socioemotional difficulties at ages 7 and 11. There was also a pattern of higher socioemotional difficulties at ages 5 and 7 and increased BMI at ages 7 and 11 years.

Table 8. 1 Correlations between BMI and socioemotional difficulties

	BMI Age 3	BMI Age 5	BMI Age 7	BMI Age 11	SDQ Age 3	SDQ Age 5	SDQ Age 7	SDQ Age 11
BMI Age 3		0.60***	0.53***	0.43***	0.01	0.01	0.02	0.03
BMI Age 5	0.43***		0.82***	0.66***	0.01	0.00	0.01	0.03
BMI Age 7	0.42***	0.74***		0.81***	0.00	0.02	0.04*	0.07***
BMI Age 11	0.33***	0.60***	0.81***		0.05**	0.05**	0.12***	0.12***
SDQ Age 3	0.01	0.02	0.04*	0.05**		0.62***	0.56***	0.48***
SDQ Age 5	0.01	0.05**	0.09***	0.07***	0.61***		0.69***	0.57***
SDQ Age 7	0.02	0.02**	0.04*	0.05**	0.53***	0.73***		0.68***
SDQ Age 11	-0.00	0.03	0.06**	0.06***	0.47***	0.64***	0.71***	

Notes: BMI, Body Mass Index; SDQ, total socioemotional difficulties score; correlations for girls (N=3,247) appear in the upper triangle and correlations for boys (N=3,157) are in the lower triangle

8.2. 1 Partially adjusted model

In the partially adjusted model for girls, using complete case analysis, both directions of cross-lagged paths between socioemotional difficulties and BMI at age 7 to 11 years were statistically significant, with p-values of <0.001. Standardised coefficients showed a larger path from BMI at age 7 to socioemotional difficulties at age 11 (β 0.085, 95% CI 0.040 – 0.129) than from socioemotional difficulties at age 7 to BMI at age 11 years

(β 0.080, 95% CI 0.030 – 0.118). However, confidence intervals overlap indicating a non-significant difference in paths.

Table 8. 2 Girls partially adjusted path coefficients (95% CI) for analysis of socioemotional difficulties and BMI at multiple time points (standardised and non-standardised estimates).

Complete case (N=3,662)

Paths		B	95% CI	β	95% CI
From BMI to socioemotional difficulties					
Age 3	⟶ Age 5	-0.023	-0.097 - 0.051	-0.009	-0.038 - 0.020
Age 5	⟶ Age 7	-0.081	-0.176 - 0.013	-0.028	-0.062 - 0.005
Age 7	⟶ Age 11	0.201***	0.091 - 0.312	0.085***	0.038 - 0.132
From socioemotional difficulties to BMI					
Age 3	⟶ Age 5	-0.008	-0.020 - 0.002	-0.024	-0.058 - 0.008
Age 5	⟶ Age 7	0.003	-0.025 - 0.018	0.006	-0.050 - 0.037
Age 7	⟶ Age 11	0.059***	0.034 - 0.083	0.080***	0.046 - 0.115

FIML (N=6,477)

Paths		B	95% CI	β	95% CI
From BMI to socioemotional difficulties					
Age 3	⟶ Age 5	-0.014	-0.083 - 0.054	-0.005	-0.033 - 0.021
Age 5	⟶ Age 7	-0.039	-0.129 - 0.049	-0.014	-0.045 - 0.017
Age 7	⟶ Age 11	0.153***	0.060 - 0.247	0.066**	0.025 – 0.106
From socioemotional difficulties to BMI					
Age 3	⟶ Age 5	0.000	0.436 - 0.649	0.000	-0.031 - 0.031
Age 5	⟶ Age 7	-0.004	-0.022 - 0.013	-0.009	-0.045 - 0.026
Age 7	⟶ Age 11	0.027*	0.002 - 0.051	0.037*	0.004 - 0.070

Standardised cross-sectional correlations

Age	Complete case ρ	FIML ρ
Age 3	-0.000	-0.014
Age 5	-0.032	0.038
Age 7	0.056*	0.041*
Age 11	-0.003	-0.005

* Longitudinal weights for sample design and response rates were employed in all analysis complete case analysis

** Cross-sectional weights for sample design and response rates were employed in all FIML analysis

For each standard deviation increase in girls BMI at age 7, socioemotional difficulties scores increased by 0.085 standard deviates. There were no significant paths between BMI and socioemotional difficulties at other ages.

Table 8. 3 Boys partially adjusted path coefficients (95% CI) for analysis of socioemotional difficulties and BMI at multiple time points (standardised and non-standardised estimates).

Complete case (N=3,584)

Paths	B	95% CI	β	95% CI
From BMI to socioemotional difficulties				
Age 3 ⟶ Age 5	0.033	-0.037 - 0.104	0.014	-0.014 - 0.043
Age 5 ⟶ Age 7	-0.012	-0.099 - 0.074	-0.004	-0.032 - 0.024
Age 7 ⟶ Age 11	0.038	-0.076 - 0.153	0.013	-0.027 - 0.055
From socioemotional difficulties to BMI				
Age 3 ⟶ Age 5	0.001	-0.009 - 0.012	0.004	-0.027 - 0.037
Age 5 ⟶ Age 7	0.017**	0.005 - 0.029	0.041**	0.013 - 0.069
Age 7 ⟶ Age 11	0.003	-0.018 - 0.025	0.006	-0.029 - 0.041

FIML (N=6,635)

Paths	B	95% CI	β	95% CI
From BMI to socioemotional difficulties				
Age 3 ⟶ Age 5	0.012	-0.046 - 0.071	0.004	-0.018 - 0.027
Age 5 ⟶ Age 7	-0.010	-0.089 - 0.068	-0.003	-0.029 - 0.022
Age 7 ⟶ Age 11	0.067	-0.045 - 0.180	0.023	-0.015 - 0.063
From socioemotional difficulties to BMI				
Age 3 ⟶ Age 5	0.004	-0.005 - 0.015	0.013	-0.017 - 0.044
Age 5 ⟶ Age 7	0.010	-0.002 - 0.023	0.024	-0.006 - 0.055
Age 7 ⟶ Age 11	0.000	-0.016 - 0.016	0.000	-0.028 - 0.029

Standardised cross-sectional correlations

Age	Complete case ρ	FIML ρ
Age 3	-0.000	0.011
Age 5	0.025	0.027
Age 7	-0.043*	-0.016
Age 11	0.015	0.000

* Longitudinal weights for sample design and response rates were employed in all analysis complete case analysis
** Cross-sectional weights for sample design and response rates were employed in all FIML analysis

There was a significant cross-sectional correlation between BMI and socioemotional difficulties at age 7 (ρ 0.056, p<0.001), but not at any other age. Paths from socioemotional difficulties from each age to the next had beta coefficients of approximately β 0.500. The standardised paths from BMI at each age to the next indicate the stability of BMI gets stronger with age; for example, the path from BMI at age 3 to age 5 was β 0.572; from age 5 to 7 was β 0.680, and from age 7 to 11 was β 0.737.

For boys, there was a significant path between socioemotional difficulties at age 5 and BMI at 7 years; β 0.041, p=0.024, but at no other age. Similar to estimates for girls, there was a cross-sectional correlation between BMI and socioemotional difficulties at age 7, but not at other ages. The paths between socioemotional difficulties at one point to the next appear less stable for boys than for girls (see Figures 8.5 and 8.6). The paths for BMI from one age to the next for boys was similar to that for girls, for example, the path at age 5 to 7 was β 0.673 for boys and β 0.680 for girls. However, the path for BMI at ages 3 to 5 was weaker for boys than for girls.

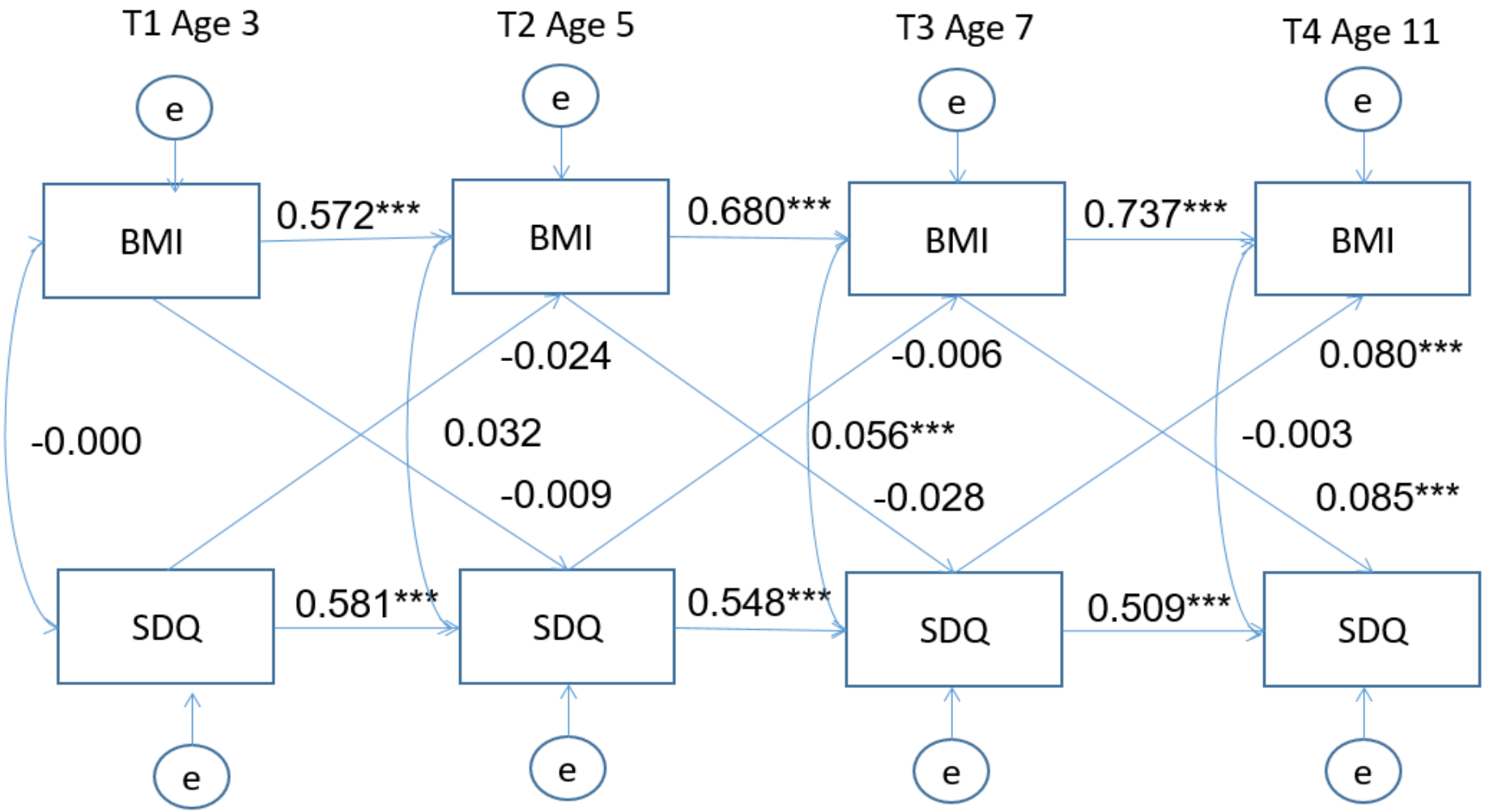

Figure 8. 5 Standardised, complete case girls longitudinal cross-lagged effects model of BMI and socioemotional difficulties adjusted for covariates (n=3,662)

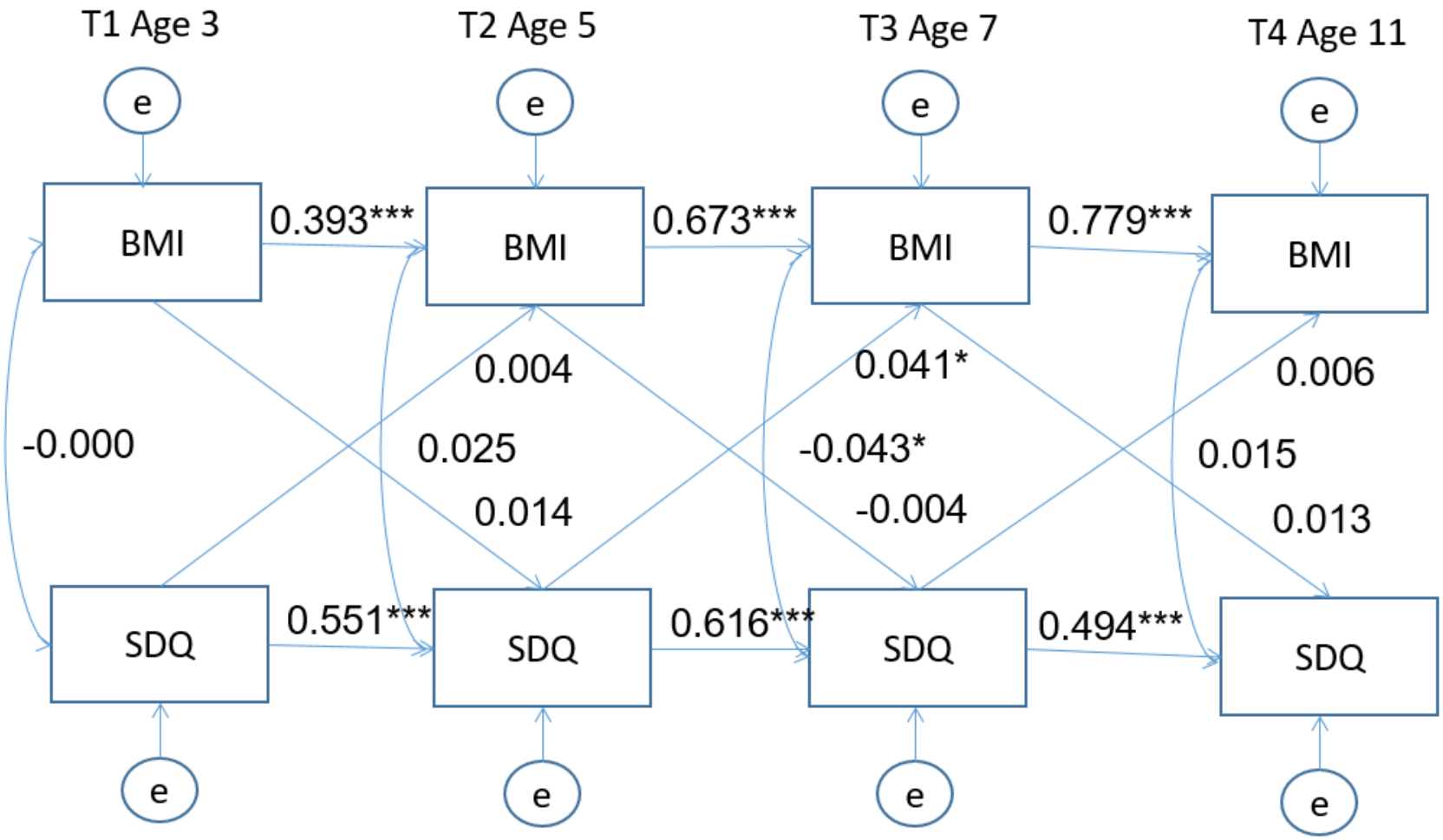

Figure 8. 6 Standardised, complete case boys longitudinal cross-lagged effects model of BMI and socioemotional difficulties adjusted for covariates (n=3,584)

8.2. 2 Full information maximum likelihood models

Results from the FIML analysis of the same models show a similar pattern between socioemotional difficulties and BMI for girls. There were significant paths between BMI and socioemotional difficulties at age 7 and 11 but with comparatively smaller beta coefficients than for the complete case analysis. The path from socioemotional difficulties at age 7 to BMI at 11 years, showed that for every standard deviation increase in socioemotional difficulties there was a 0.037 standard deviation increase in BMI (95% CI 0.004 – 0.070, p=0.028). However, the path from BMI at age 7 to socioemotional difficulties at age 11 was larger, with a beta coefficient of 0.066 (95% CI 0.025 – 0.106) (see Figure 8.7). For boys, there were no significant cross-lagged paths between BMI and socioemotional difficulties at any age (see Figure 8.8).

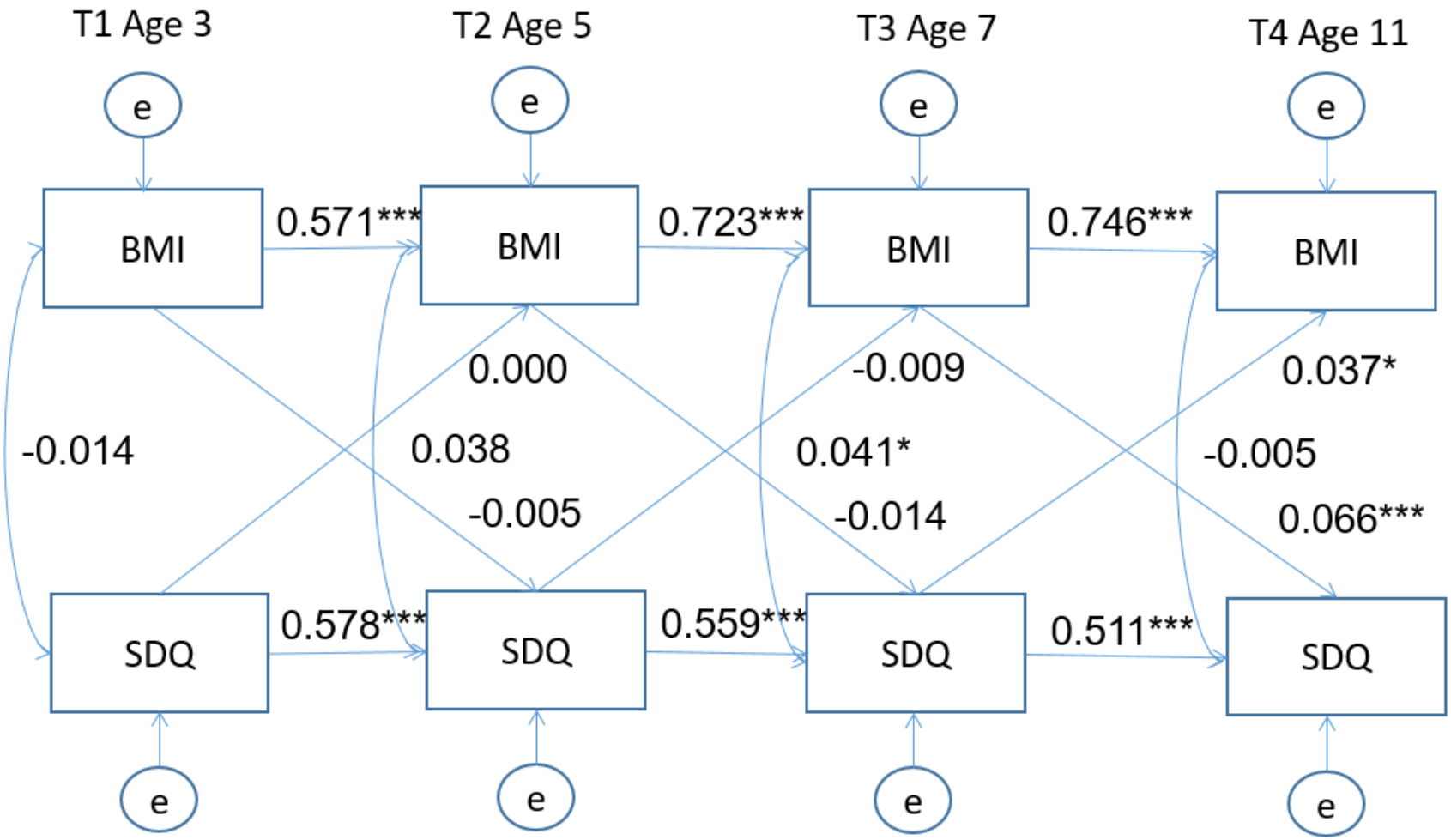

Figure 8. 7 Standardised, FIML girls longitudinal cross-lagged effects model of BMI and socioemotional difficulties adjusted for covariates (n=6,477)

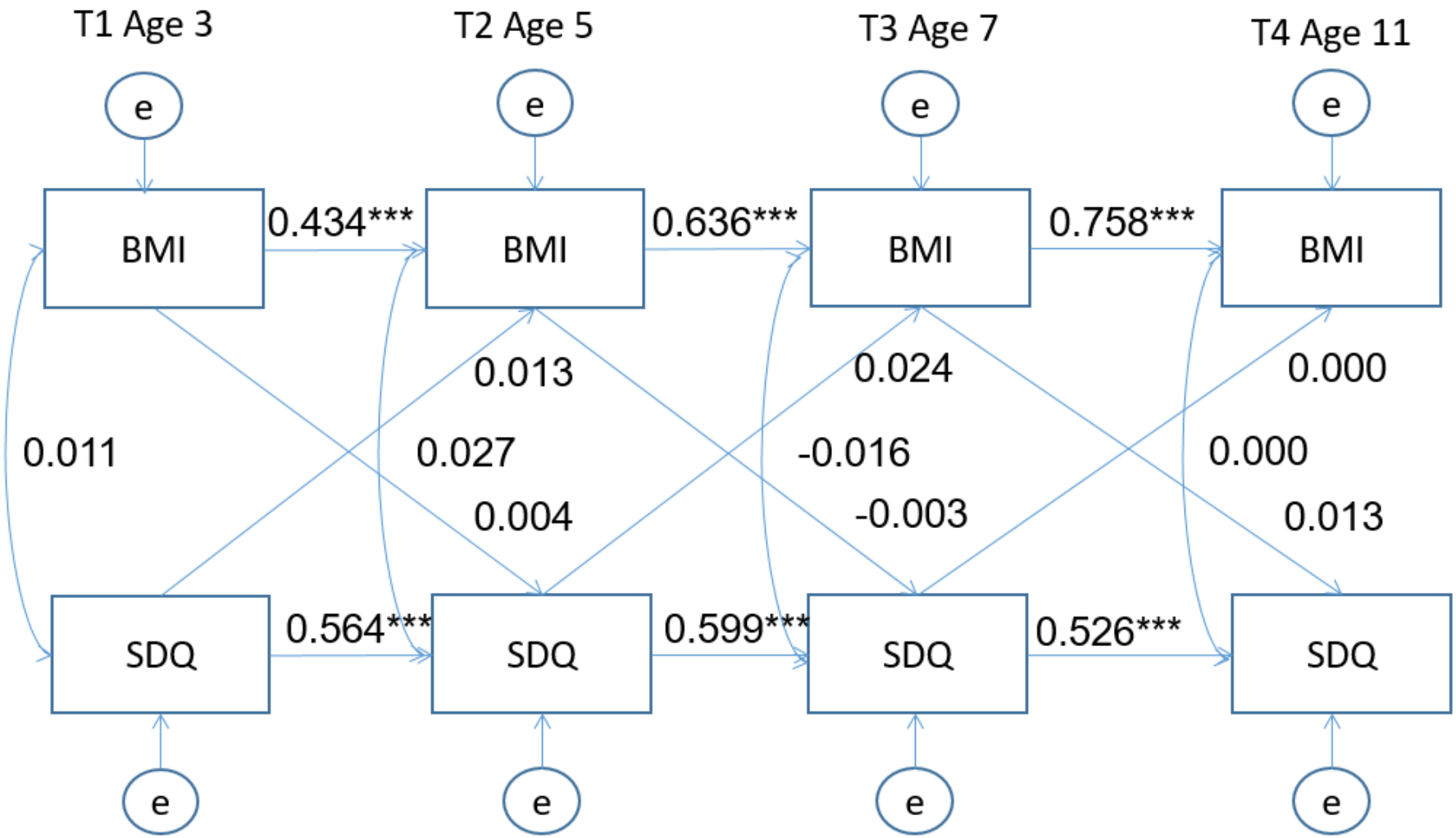

Figure 8. 8 Standardised, FIML boys longitudinal cross-lagged effects model of BMI and socioemotional difficulties adjusted for covariates (n=6,635)

8.2. 3 Fully adjusted model

Using complete case analysis to adjust for the psychosocial environment children are exposed to, additional paths from the four stressors to BMI and socioemotional difficulties at each age were added to the model. With these additional paths, beta coefficients between BMI and socioemotional difficulties barely changed. For girls, the path between socioemotional difficulties at age 7 and BMI at age 11 became slightly larger, with a coefficient of β 0.090 (95% CI 0.051 – 0.129, p<0.001, compared with β 0.080, 95% CI 0.046 - 0.115 in the previous model). For unstandardized estimates, this meant that for every 1 point increase in SDQ score at 7, BMI increased by 0.067 (95% CI 0.039 - 0.095). For the opposite direction, the association between BMI at age 7 and socioemotional difficulties at age 11, had a beta coefficient of β 0.087 (95% CI 0.034 – 0.139, p<0.001). Fully adjusted estimates for standardised and non-standardised models are shown in table 8.4.

Adjustment for the psychosocial environment made little difference to model estimates for boys (figure 8.10). Beta coefficients were higher after the addition of paths from stressors to outcomes. There was a significant path from socioemotional difficulties at age 5 to BMI at 7 years; β 0.045 (p<0.05). As with the previous model, there was a significant cross-sectional correlation between BMI and socioemotional difficulties at age 7 (ρ -0.048, p<0.05).

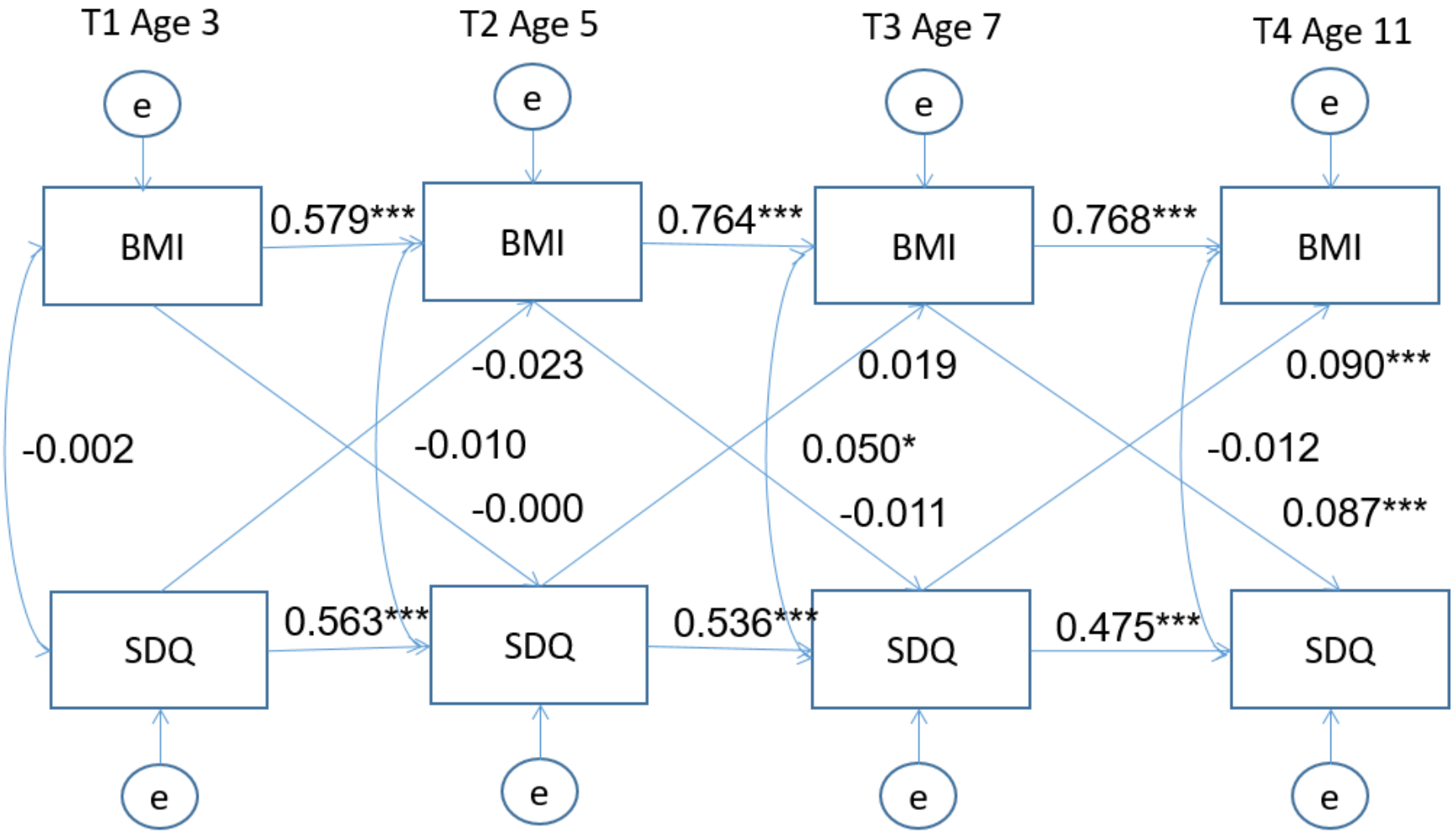

Figure 8. 9 Standardised, complete case girls longitudinal cross-lagged effects model of BMI and socioemotional difficulties fully adjusted for covariates and psychosocial stressors (n=3,247)

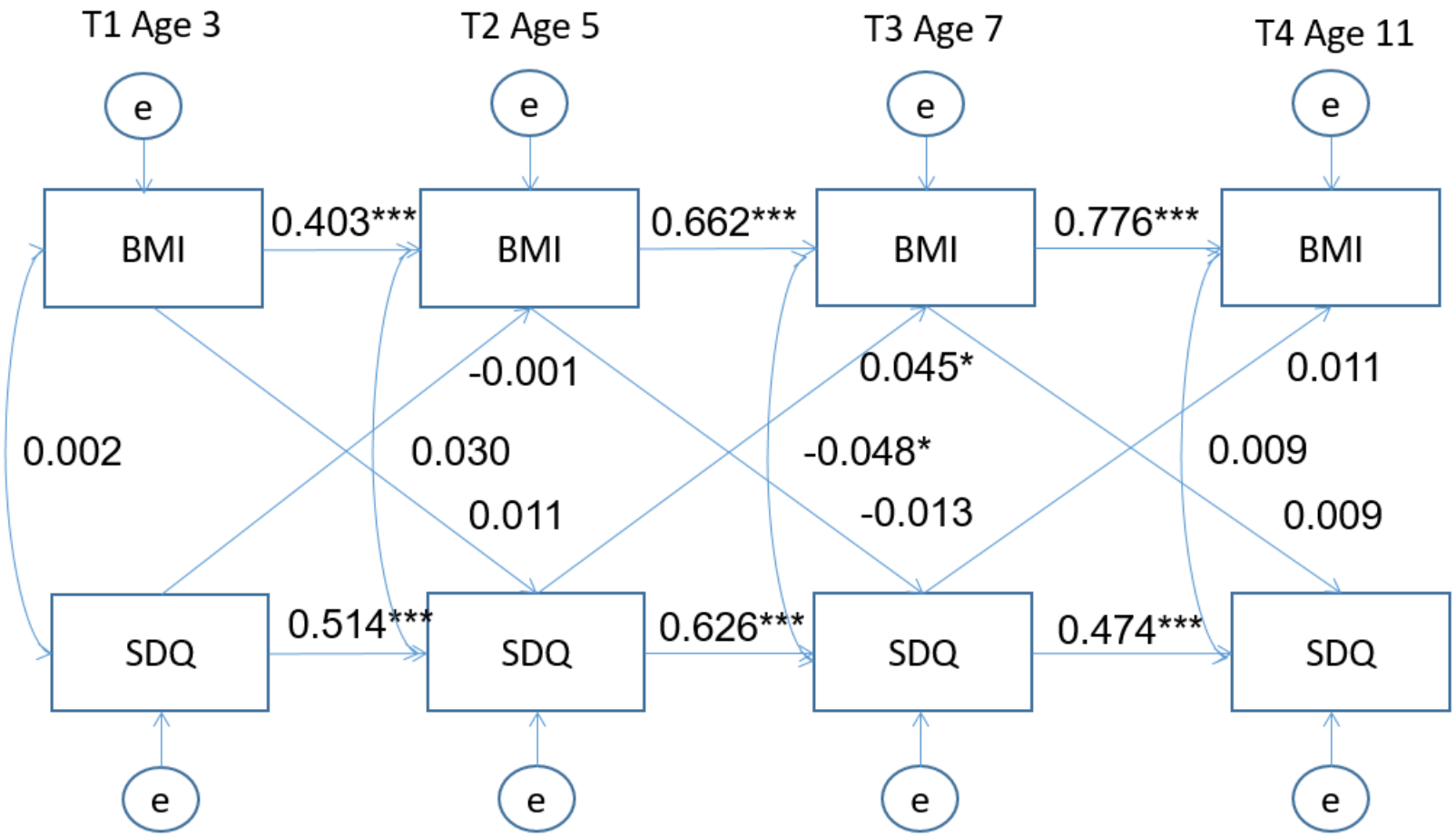

Figure 8. 10 Standardised, complete case boys longitudinal cross-lagged effects model of BMI and socioemotional difficulties fully adjusted for covariates and psychosocial stressors (n=3,157)

Table 8. 4 Girls fully adjusted path coefficients (95% CI) for analysis of socioemotional difficulties and BMI at multiple time points (standardised and non-standardised estimates).

Complete case (N=3,247)

Paths		B	95% CI	β	95% CI
From BMI to socioemotional difficulties					
Age 3	⟶ Age 5	-0.001	-0.086 - 0.082	-0.000	-0.035 - 0.033
Age 5	⟶ Age 7	-0.033	-0.131 - 0.064	-0.011	-0.046 - 0.022
Age 7	⟶ Age 11	0.198**	0.054 - 0.342	0.087**	0.023 - 0.150
From socioemotional difficulties to BMI					
Age 3	⟶ Age 5	-0.008	-0.020 - 0.004	-0.023	-0.058 - 0.012
Age 5	⟶ Age 7	0.010	-0.007 - 0.027	0.019	-0.013 - 0.053
Age 7	⟶ Age 11	0.067***	0.039 - 0.095	0.090***	0.051 - 0.128

FIML (N=6,477)

Paths		B	95% CI	β	95% CI
From BMI to socioemotional difficulties					
Age 3	⟶ Age 5	-0.016	-0.083 - 0.050	-0.006	-0.033 - 0.020
Age 5	⟶ Age 7	-0.040	-0.128 - 0.048	-0.014	-0.045 - 0.017
Age 7	⟶ Age 11	0.136**	0.052 - 0.221	0.061**	0.023 – 0.099
From socioemotional difficulties to BMI					
Age 3	⟶ Age 5	-0.000	0.436 - 0.648	-0.000	-0.031 - 0.030
Age 5	⟶ Age 7	-0.005	-0.022 - 0.012	-0.010	-0.044 - 0.024
Age 7	⟶ Age 11	0.028*	0.004 - 0.052	0.039*	0.006 - 0.071

Standardised cross-sectional correlations

Age	Complete case ρ	FIML ρ
Age 3	-0.002	-0.021
Age 5	-0.010	0.039
Age 7	0.050*	0.039*
Age 11	-0.012	-0.015

* Longitudinal weights for sample design and response rates were employed in all analysis complete case analysis

** Cross-sectional weights for sample design and response rates were employed in all FIML analysis

Table 8. 5 Boys fully adjusted path coefficients (95% CI) for analysis of socioemotional difficulties and BMI at multiple time points (standardised and non-standardised estimates).

Complete case (N=3,157)

Paths		B	95% CI	β	95% CI
From BMI to socioemotional difficulties					
Age 3	⟶ Age 5	0.025	-0.055 - 0.107	0.011	-0.023 - 0.045
Age 5	⟶ Age 7	-0.039	-0.124 - 0.045	-0.013	-0.042 - 0.015
Age 7	⟶ Age 11	0.025	-0.086 - 0.136	0.009	-0.033 - 0.052
From socioemotional difficulties to BMI					
Age 3	⟶ Age 5	-0.000	-0.013 - 0.012	-0.001	-0.037 - 0.035
Age 5	⟶ Age 7	0.020**	0.007 - 0.033	0.045**	0.016 - 0.074
Age 7	⟶ Age 11	0.006	-0.015 - 0.029	0.011	-0.024 - 0.046

FIML (N=6,635)

Paths		B	95% CI	β	95% CI
From BMI to socioemotional difficulties					
Age 3	⟶ Age 5	-0.001	-0.060 - 0.056	-0.000	-0.023 - 0.022
Age 5	⟶ Age 7	-0.010	-0.088 - 0.067	-0.003	-0.029 - 0.022
Age 7	⟶ Age 11	0.043	-0.060 - 0.147	0.016	-0.022 - 0.054
From socioemotional difficulties to BMI					
Age 3	⟶ Age 5	0.004	-0.005 - 0.015	0.013	-0.017 - 0.044
Age 5	⟶ Age 7	0.010	-0.002 - 0.023	0.023	-0.006 - 0.053
Age 7	⟶ Age 11	-0.000	-0.017 - 0.016	-0.000	-0.006 - 0.053

Standardised cross-sectional correlations

Age	Complete case ρ	FIML ρ
Age 3	0.002	0.006
Age 5	0.030	0.023
Age 7	-0.048*	-0.018
Age 11	0.009	0.004

* Longitudinal weights for sample design and response rates were employed in all analysis complete case analysis
** Cross-sectional weights for sample design and response rates were employed in all FIML analysis

8.2. 4 Full information maximum likelihood

For the final model, using FIML analysis results were much the same as for the partially adjusted model. For girls, after adding in paths for psychosocial stressors, the path between socioemotional difficulties at age 7 to BMI at age 11 years had a path coefficient of β 0.039 ($p<0.05$) (see Figure 8.11). The magnitude of the association between BMI at age 7 to socioemotional difficulties at age 11 was larger, with a beta coefficient of β 0.061 ($p<0.001$). Unstandardized coefficients showed that for each point increase in BMI at 7 years, SDQ scores increased by 0.136 for girls (95% CI

0.052 - 0.221). The cross-sectional correlation between BMI and socioemotional difficulties at age 7 was ρ 0.039 ($p<0.05$). For boys, there were no significant cross-lagged paths between BMI and socioemotional difficulties at any age (see Figure 8.12).

8.2. 5 Internalising and externalising subscales

As there might have been some aspect of socioemotional difficulties (either internalising or externalising behaviours) driving associations, to understand pathways further the final model was also run using externalising and internalising subscales using complete case analysis. For girls, the path estimates from BMI to internalising difficulties were larger than for total socioemotional difficulties. For example, the path from BMI at age 7 to internalising score at age 11, had a beta coefficient of β 0.104 (95% CI 0.041 – 0.166, $P<0.001$) compared to β 0.087 for total difficulties (see Figure A8.1 in Appendix 8). The path from the internalising score at age 7 to BMI at age 11 years had a beta coefficient of β 0.055 (CI 0.024 – 0.086, $P<0.001$).

For boys, similar to analysis for total socioemotional difficulties, there were no significant paths between BMI and internalising difficulties (see Figure A8.2 in Appendix 8).

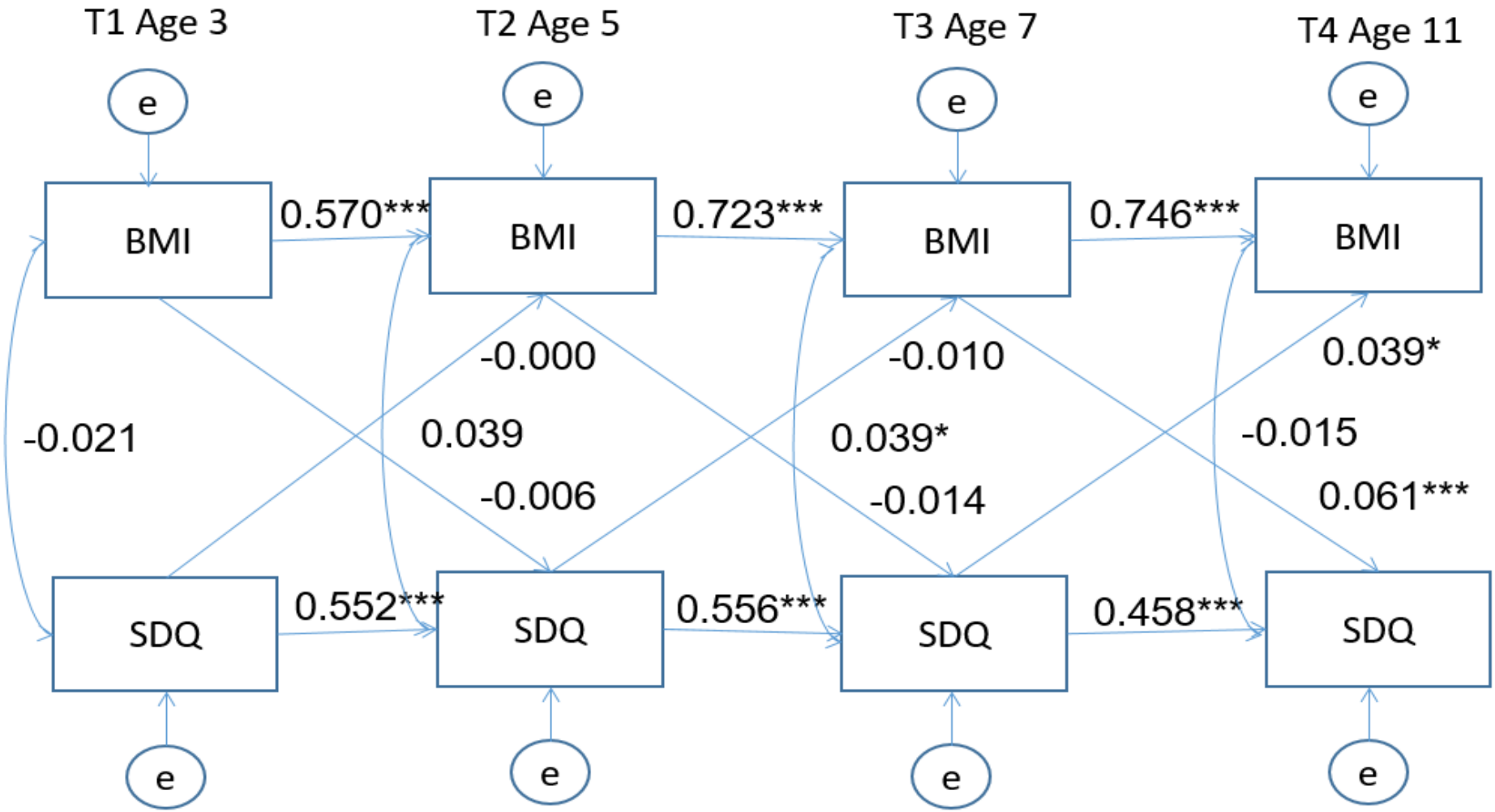

Figure 8. 11 Standardised, FIML girls longitudinal cross-lagged effects model of BMI and socioemotional difficulties adjusted for covariates and psychosocial stressors (n=6,477)

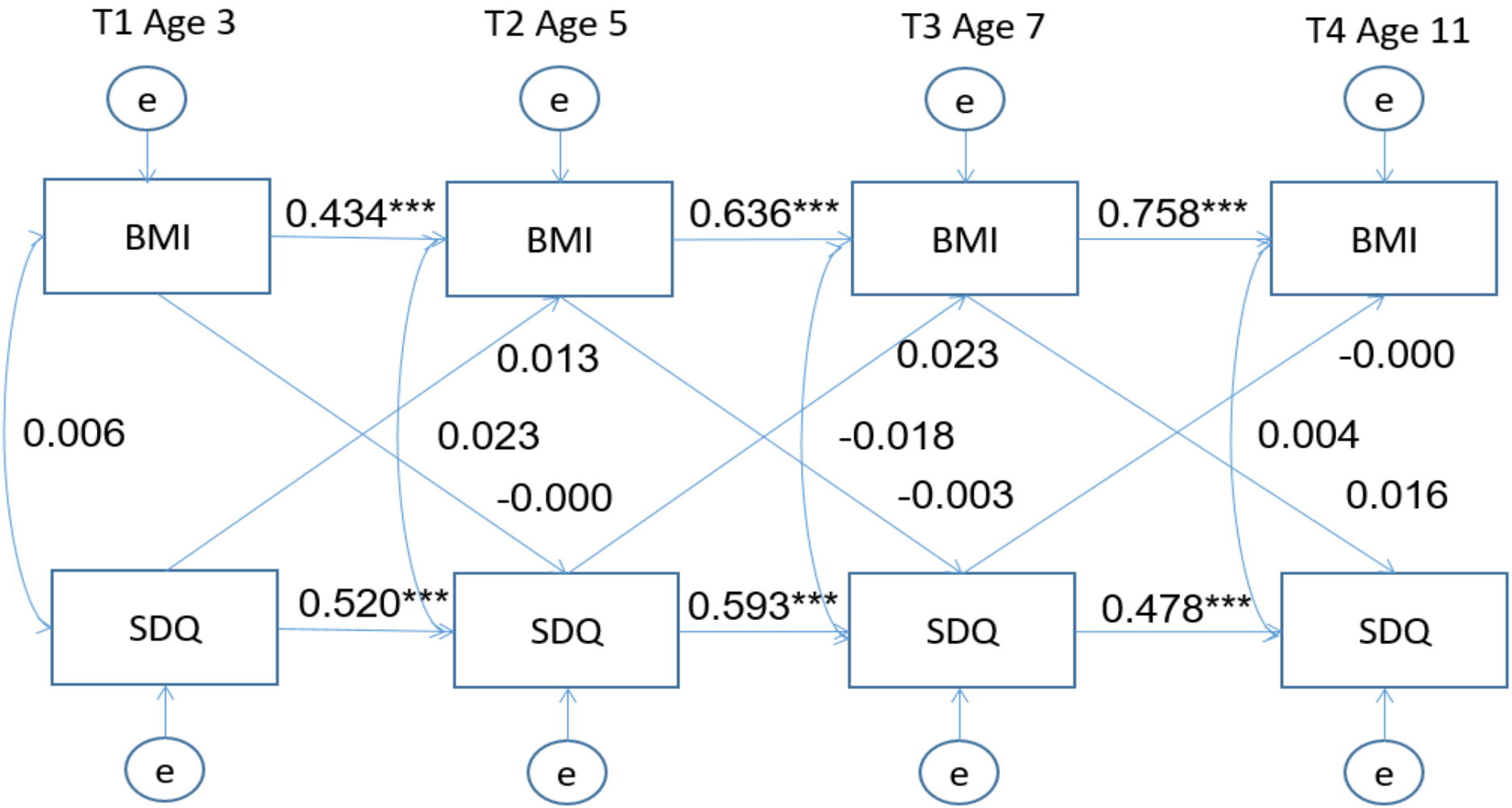

Figure 8. 12 Standardised, FIML boys longitudinal cross-lagged effects model of BMI and socioemotional difficulties adjusted for covariates and psychosocial stressors (n=6,635)

For externalising difficulties, the direction from BMI at age 7 to socioemotional difficulties at age 11 for girls was just short of the 95% significance level (p=0.064), but still showed a positive association between BMI and socioemotional difficulties (β 0.045, CI -.002 - .094, see Figure A8.3 in Appendix 8). For the opposite direction; from externalising score at age 7 to BMI at age 11 the path was significant, with a beta coefficient of β 0.082 (CI 0.045 – 0.119, P<0.001). For boys, there were no significant paths between BMI and externalising difficulties at any age. Findings support that for girls, the relationship from BMI to socioemotional difficulties is driven by emotional and peer and relationship problems.

8.2. 6 Summary of results

Complete case cross-lagged structural equation models showed significant paths between BMI and socioemotional difficulties in both directions from age 7 to age 11 years for girls. FIML analysis supported these findings and showed estimates were slightly larger from BMI to socioemotional difficulties, compared to socioemotional difficulties to BMI.

Subscale analysis showed that much of the association from BMI to socioemotional difficulties for girls was driven by internalising difficulties. Looking at the opposite direction, in contrast, the path from externalising scores to BMI (from ages 7 to 11) was significant, but the path coefficient from internalising scores to BMI fell short of statistical significance. Findings highlight that girls with higher BMI's are more likely to have internalising difficulties at older ages, and girls with externalising difficulties are more likely to have higher BMI's at older ages.

For boys there was a significant path from total socioemotional difficulties at age 5 to BMI at age 7, however, this path was not replicated in the subscale or FIML analysis.

8.3 Discussion

As there is greater literature supporting the pathway from higher BMI to socioemotional difficulties, compared to socioemotional difficulties to BMI, I hypothesised that the strongest path would be from BMI earlier in childhood to socioemotional difficulties at older ages. Findings for girls' FIML total socioemotional difficulties and internalising subscale analysis supported this hypothesis. Findings also showed some evidence of an association in the opposite direction and there was some evidence that externalising difficulties led to higher BMI's at older ages for girls. There was only a tenuous association between BMI and socioemotional difficulties for boys. The second hypothesis, hypothesis 5.2 presented in chapter 3, was that the association between BMI and socioemotional difficulties would be partially explained by psychosocial stressors, but there was no evidence to support this. Findings are now discussed in comparison to the existing literature.

8.3. 1 Comparison to literature

Previous papers analysing the relationship between obesity and mental health in childhood have largely focused on how being overweight or obese affects psychological well-being. The findings from this thesis give more support to this direction of association in girls, with a highly significant path between BMI at age 7 to socioemotional difficulties at age 11 years. The literature suggests obese children can have a negative self-image from a very young age, with higher levels of psychological distress and low self-esteem from very early in childhood (Hesketh et al., 2004, Gibson et al., 2008). Yet, there were significant paths from middle childhood to pre/early adolescence only. One reason for this could be the longer time lag between 7 years and 11 years. Another possible explanation could be that girls are more emotionally sensitive to the effects of being overweight later in childhood as pre/early adolescence is a time of dynamic developmental changes, the manifestation of which can be observed in social and emotional behaviours (Perry, 2000). Or that girls experience

more peer victimisation and social exclusion due to being overweight at older ages in childhood (Griffiths et al., 2006, Bacchini et al., 2015, Griffiths and Page, 2008a).

For example, findings from an Australian cohort (n=1,157) of children age 5 to 10 years old showed that after accounting for baseline self-esteem, higher BMI was associated with lower self-esteem at follow up (Hesketh et al., 2004). This study used linear regression and controlled for very few potential confounders. Data were collected between 1997 and 2000 so findings are for children who were born in the nineties. This thesis uses more recent data, updating the literature using more sophisticated analysis and data on children born in the new Millennium in the UK.

One possible explanation for the association between BMI and socioemotional difficulties in childhood is the social stigma surrounding being overweight or obese. A Canadian study found that obese girls from as young as 3 years old were subjected to victimisation (Qualter et al., 2015). Similar to this thesis, Qualter and colleagues (2015) used a cross-lagged panel design to examine the cross-lagged effects of BMI and victimisation, whilst controlling for the within-time associations and the effects of family adversity variables for children aged 3 to 10 years. Their results reflect the thesis findings, with BMI predicting annual increases in victimization for girls aged 6 years and over. Furthermore, victimisation predicted annual increases in BMI for girls after age 6 years. Unlike this thesis, Qualter et al (2015) measured family adversity as low income and single-parenthood but did not adjust for the possible confounding by psychosocial stressors or other sociodemographic factors. This could be one reason why they found larger effect sizes than the present study. Also, there may be a stronger association between victimisation and BMI than for socioemotional difficulties.

Further studies have found weight-related victimisation in peer relationships for girls in childhood and adolescence (Griffiths and Page, 2008b, Griffiths et al., 2011). The thesis findings lends further support to this as increased BMI was shown to be associated with increased emotional and peer relationship problems for girls. A study which used the ALSPAC dataset found, using logistic regression, that both obese boys

and girls at age 7.5 years, were over 50% more likely to experience bullying at age 8.5 years (Griffiths et al., 2006). Also, obese boys were 1.66 times more likely to be bullies themselves. In comparison, this thesis only found an equivocal association between socioemotional difficulties at age 5 and BMI at age 7 years for boys, which was not replicated in FIML or subscale analysis.

Consistent with this thesis, a study using cross-sectional logistic regression in MCS data, found obese children ages 3 and 5 were more likely to have socioemotional difficulties (Griffiths et al, 2011). After controlling for prior difficulties and weight status, associations were fully attenuated. The findings of Griffiths and colleagues lend support to the relationship between socioemotional difficulties and obesity being weaker at younger ages. Using a more sophisticated method to account for cross-sectional correlations between BMI and socioemotional difficulties, a wide range of confounders and other possible paths, this thesis has shown that associations are stronger at older ages.

In comparison to the literature reporting how being obese affects children's mental health, there has been much less analysis of how the relationship operates in the opposite direction; that having socioemotional difficulties may increase children's likelihood to gain weight. Although there is evidence that change in appetite can be a feature of depression (Pettit et al., 2006, W. Kyle Simmons et al., 2016), studies have tended to look at how poor mental health predicts other measures of physical health or obesity in adulthood (Trzesniewski et al., 2006, Wickrama et al., 2005).

This study found support, albeit weaker in the FIML findings, for the association between socioemotional difficulties at age 7 and BMI at age 11 in girls. Analysis using the externalising subscale supported this direction of association. Studies which have looked at how mental health is associated with weight status have often found non-significant results (Roberts and Duong, 2015, Roberts and Duong, 2013). However, a study in the U.S. found major depressive disorder was associated with almost a

threefold increase in odds (OR 2.7, 95% CI 1.1 – 7.1) of obesity for male adolescents (12-19 years) after adjustment for sex, age, ethnicity and poverty. However, the study was cross-sectional, limiting the interpretation of results (Merikangas et al., 2012).

There is evidence to support that children with ADHD are more likely to gain weight (Cortese and Vincenzi, 2012). An increasing number of studies have tried to understand possible mechanisms underlying the link between ADHD and obesity, such as the role of abnormal eating patterns and sedentary behaviours (Cortese and Tessari, 2017). In a recent meta-analysis of 42 international studies, a significant association was found for the relationship between ADHD and obesity in children (OR 1.20, 95% CI 1.05–1.37) and adults (OR 1.55, 95% CI 1.32–1.81) (Cortese et al., 2016). However, a common drawback of studies is that they do not control for the possible confounding effect of other mental health comorbidities (Cortese and Tessari, 2017). More studies are required to understand the pathway from externalising behaviour to obesity for girls in childhood.

8.3. 2 Strengths and limitations

In this chapter, complete case results were compared to findings using FIML. For analysis with a larger sample size, the magnitude of estimates were reduced, indicating that path coefficients may be overestimated in smaller samples. However, estimates for the complete case analysis showed the same level of significance for the path between socioemotional difficulties and BMI for girls, indicating that although estimates may be larger for the complete case analysis the significance of paths can be trusted. Part of the slight differences observed for the complete case and FIML results could be because of differences in sample characteristics. From the substantive analysis in chapters 5 and 6, the complete case samples were more socioeconomically advantaged, had more socioemotional difficulties and were less likely to have been exposed to stressors.

This study has investigated the bi-directional relationship between BMI and socioemotional difficulties. Findings add to the understanding of pathways which lead to socioemotional difficulties and obesity. The study looked at a wide range of potential confounding factors (maternal age at birth; maternal smoking status; maternal pre-pregnancy BMI; income; occupational class; and parental education), including measures of the psychosocial environment (parenting limiting longstanding illness; parental relationship change; parent-child conflict; maternal depression). A strength of the analysis is that by controlling for covariates measured at each time point, the analysis potentially controls for time-varying confounding factors. Controlling for psychosocial stressors had little effect on estimates, indicating that stressors did not explain the relationship between BMI and socioemotional difficulties.

A strength of the cross-lagged path model is that in addition to allowing for the estimation of cross-lagged effects, models control for correlations between variables within time-points and autoregressive effects, or stability across time in BMI and socioemotional difficulties over time (Kearney, 2017). The large coefficients indicate stability in BMI and socioemotional difficulties from one-time point to the next. A further strength is that in order to make claims about the association between variables models compare relative sizes by standardising variables. However, standardisation does not necessarily address fundamental differences in distributions, which should be a consideration when interpreting results (Kearney, 2017). Furthermore, cross-lagged path models do not represent the actual within-person relationships over time, preventing drawing conclusions regarding causal influences.

This study has other important limitations. First, as with all analysis using observational data, findings do not prove causality, they simply point to associations. Second, even though a large number of confounders were examined there may be residual confounding from other factors that are not measured in the MCS, such as the school environment or peer victimisation. For example, in schools with insufficient anti-bullying policies, children who are overweight or obese might face more victimisation. The

strengths and limitations of this work are discussed in greater detail in the next chapter, the overall discussion chapter, Chapter 9.

Chapter 9: Discussion

This thesis adds to the literature on the relationship of family psychosocial stressors in the home environment with childhood socioemotional difficulties and obesity. This final chapter reviews the principal findings with reference to the theoretical underpinnings, as outlined in chapter two. The strengths and limitations from the previous four empirical chapters (chapters five to eight) are synthesized. Then the policy implications of findings are discussed within the wider socio-political context which was also described in chapter two. Lastly, future directions of analysis and final conclusions are drawn.

9.1 Summary of principal findings

The aim of this research was to investigate the relationship of psychosocial stressors in the home environment with socioemotional difficulties and obesity in members of the MCS, hypothesising that psychosocial stressors will affect family functioning and the resulting home environment, putting children at risk of socioemotional difficulties and obesity. The objectives were to:

- To examine the cross-sectional and longitudinal associations of four stressors (parental limiting longstanding illness, parental relationship change, parent-child conflict and maternal depression) with socioemotional difficulties and obesity.
- To examine the potential moderating effects of health behaviours and family structure on associations.
- To examine longitudinal pathways between obesity and socioemotional difficulty scores across the first decade of life.

All psychosocial stressors were associated with increased odds of socioemotional difficulties, but associations between psychosocial stressors and obesity were found only for stressors pertaining to parental health. Drawing on Conger's Family Stress

Model to explain associations between stressors and child health (Conger et al., 2010, Conger and Conger, 2002, Conger, 1994), it could be that parental distress may strain relationships and disrupt parenting, resulting in a detrimental impact on children's development.

The psychosocial stressors with the largest associations with children's socioemotional difficulties were parent-child conflict and maternal depression. Within the conceptual framework outlined in chapter three, these stressors were conceptualised as more proximal to children's day-to-day lives. In Bronfenbrenner's bioecological theory of human development, children are at the centre of five interrelated hierarchical systems of socialisation, moving from the most proximal to the most remote (Bronfenbrenner, 1979, Bronfenbrenner, 2005). This thesis focused on the inner system of socialisation, the microsystem, which describes the immediate social environment of children's lives. Evidence suggested that those psychosocial stressors which are more proximal to children's day-to-day experiences, parent-child conflict and maternal depression, had the largest cross-sectional and longitudinal associations with socioemotional difficulties. This supports the theory, in that the immediate psychosocial environment in children's lives had more influence over children's mental health than more distal factors.

The accumulation of risk model builds on Riley's theory of insult accumulation (Riley, 1989). The concept proposes repeated exposure to the same adversity across life can accumulate, negatively impacting on health outcomes. However, this thesis found limited evidence to support the accumulation of risk model, as children who were exposed to stressors at multiple time points were at no greater risk of socioemotional difficulties or obesity than children not exposed to these stressors. The only stressor that showed some evidence of accumulation of risk was parent-child conflict, but estimates for socioemotional difficulties in children who were exposed to parent-child conflict throughout childhood were similar to those for children who were exposed concurrently only. This may be evidence of hedonic adaption theory, as results support the idea that children's emotional well-being may adjust to their current life

circumstances and that all reactions are relative to prior experiences (Brickman and Campbell, 1971).

There were no apparent moderating effects by family health behaviours for the relationships between stressors and socioemotional difficulties or obesity. However, a significant interaction was found for parent-child conflict and parental relationship status: children in single-parent families, compared to two-parent families, were more likely to have socioemotional difficulties after exposure to parent-child conflict. As discussed in the literature review, there are various family structures found in the UK with a propensity towards varying social, economic and demographic compositions (Panico et al., 2010). One explanation could be that single-parents, especially if recently divorced/separated, may have less emotional capacity and time to invest in parenting (Anderson, 2014).

Another explanation for children in single-parent families exposed to parent-child conflict being at greater risk of socioemotional difficulties could be residual confounding from socioeconomic factors, as evidence shows single-parent families are at greater risk of experiencing economic hardship (Burtless, 1999). Single-parent families are likely to experience a number of further stressors that are not captured in this thesis. For example, single-parents experiencing financial hardship are more likely to report food and fuel poverty, social isolation, substandard housing, overcrowding and community violence (Stack and Meredith, 2018, Evans and English, 2002b). There can be many sources of stress in children's lives, but this thesis has focused on four psychosocial stressors in the home environment. However, I recognise that it is difficult to differentiate between psychosocial stressors and economic or material stressors and that economic and material stressors will often have a psychosocial impact on families.

Finally, cross-lagged structural equation models were used to explore the patterning between socioemotional difficulties and BMI throughout the first decade of life by sex. After accounting for maternal and family characteristics and psychosocial stressors, models showed that for girls only, socioemotional difficulties and BMI were positively

associated in both directions from ages 7 to 11 years. Girls in mid-childhood with more socioemotional difficulties were more likely to have higher BMI's in preadolescence and similarly, girls with higher BMI's were more likely to have socioemotional difficulties. The conceptual framework had hypothesised that the strongest direction of association in the relationship between the two outcomes would be from BMI to socioemotional difficulties, this was supported by findings from the FIML and internalising subscale analysis. However, as a caveat to this there was stronger evidence of the opposite direction for the externalising subscale analysis. One explanation for the association between weight status and mental health could be the negative self-image, and subsequent low-esteem experienced as a result of the stigma faced by children who are overweight or obese (Gibson et al., 2008, Hesketh et al., 2004).

9.2 Strengths and limitations

The main strength of this thesis is that it uses data from the large, nationally representative, Millennium Cohort Study (MCS). MCS is rich in longitudinal data on the social, economic and health aspects of children's lives, providing an excellent opportunity to assess how a wide range of psychosocial stressors impact on children's socioemotional difficulties and weight status over multiple sweeps. Due to the longitudinal nature of the data, analysis of timing to exposure and accumulation of risk could be investigated. It additionally allowed analysis of the moderating effects of family structure and health behaviours on the relationship between stressors and children's health. Finally, longitudinal data made it possible to analyse the patterning of socioemotional difficulties and BMI across the first decade of life, whilst adjusting for a wide range of confounding factors.

This study is one of very few in the UK to have looked at the relationship between multiple measures of psychosocial stressors with both children's socioemotional health and weight status, advancing the understanding of how stressors in the home environment can impact on health during the first decade of life. Four psychosocial stressors: parental relationship change, parental limiting longstanding illness, parent-

child conflict and maternal depression were used in the analysis, which I will now critique in turn.

Family breakdown has consistently been assessed as a serious event in the lives of children (Compas, 1987). Using the derived variable indicating divorce in MCS for analysis would have meant excluding families with parents who had not previously been married. Due to the large amount of data on family characteristics, I was able to create a variable that captured parental relationship change from one sweep to the next. One limitation of this variable is that it captures any relationship change that parents may have been through; both dissolutions and the coming together of relationships. However, I chose to do this because studies lend support to the view that families coming together, becoming 'blended', can be as stressful for children as family breakdown (Kirby, 2006a, Dunn, 2002, Dunn et al., 1998).

It could be argued that parental limiting longstanding illness (LLI) is an imprecise measure as it does not discriminate between different types of illnesses. However, it better captures parental illness as a psychosocial stressor, than say self-rated health, because it specifically asks whether the illness limits day-to-day activities in any way. Instead of more general measures of health, limiting longstanding illness captures all and any illnesses which have a debilitating impact on day-to-day activities.

Parent-child conflict was captured using the most widely used instrument for identifying domestic violence, the Conflict Tactics Scale (Strauss and Douglas, 2004). The parent-child version of the scale measures physical and psychological maltreatment of children and is a validated and reliable measure of parent-child conflict (Straus and Hamby, 1997, Straus, 1979). One possible limitation when measuring sensitive information such as parent-child conflict is reporting bias due to social desirability. However, as answers to questions were completed by respondents independent of the interviewer, bias due to social desirability should be limited. As the Conflict Tactics scale was not available at age 11, a question on whether or not parents have frequent battles with children was used as a measure of parent-child conflict. However, there

was no detail available on the severity or exact frequency of arguments. This difference in measurement at age 11 needs to be considered when interpreting results.

Maternal depression was measured by the Kessler scale (K6), which is an abbreviated version of the K10, a widely validated screening instrument for psychological distress (Kessler et al., 2003). The scale has demonstrated excellent internal consistency and reliability (Cronbach's alpha=0.89) (Kessler et al., 2002). Maternal depression has consistently been found to have detrimental effects on children's mental health (Ashman et al., 2008, Lovejoy et al., 2000, Kiernan and Huerta, 2008). However, some studies have indicated only a modest degree of agreement between different reporters of children's socioemotional difficulties, with some accounts of children's behaviour reflecting personal characteristics of the respondent, leading to questions surrounding maternal bias (Najman et al., 2001). A strength of this study is that several sensitivity analyses were performed to address this. First, differences in cross-sectional associations for maternal and paternal reported depression and socioemotional difficulties, in households that had data for both parents, were analysed at every age (3, 5, 7, and 11 years). Paternal depression was associated with increased odds of socioemotional difficulties but associations were weaker than for maternal depression. Second, sensitivity analyses were performed using teacher-reported socioemotional difficulties available at age 7 and 11 years. Associations were consistent with those for maternal depression and parental-reported socioemotional difficulties (OR 2.86, 95% CI 2.08 – 3.94), with the fully adjusted odds ratio at age 7 indicating children exposed to maternal depression had an almost two-fold increase in the risk of having high teacher-reported socioemotional difficulties.

A further strength of this thesis is that the adjustment approach made it possible to examine the contextual effects of family sociodemographic characteristics. Maternal and child characteristics and measures of family socioeconomic position were adjusted for; failure to adjust for these factors would have led to residual confounding and inaccurate estimates of associations. The characteristics of a child are the combined

result of the surrounding environment and qualities of the individual over the course of that child's life. Due to the rich data in MCS, this research was able to adjust for some child characteristics, such as sex and puberty. The contextual factors of children's lives, measured by socioeconomic factors (SEP; parental education; and family income), were also adjusted for.

Within the theoretical framework of ecological systems theory, there are also substantial impacts of other social institutions outside the family, such as school and peer groups, which this thesis has not been able to fully observe. Analysis has focused on the immediate environment surrounding the child and factors found in the microsystem that are most proximal to the developing child's day-to-day experiences. However, there are linkages and interchanges between the different institutions in children's lives and wider contextual factors, such as the socio-political conditions in which children's development sits. These interchanges between the different institutions become more important as the child grows and becomes more independent. I was unable to account for this; however, there should be little variation in experiences of socio-political conditions in birth cohort studies.

A limitation of the thesis is that only the direction from stressors to children's health was examined. Some studies have found evidence of a reciprocal relationship between children's and parent's mental health (Webb et al., 2017, Ge et al., 1995). Also within the ecological systems theory, interactions in the microsystem are not one-sided, with the personal characteristics of caregivers, family members and teachers having reciprocal influences on children (Bronfenbrenner, 1979, Bronfenbrenner, 2005).

Due to the nature of longitudinal data collection, refusal to participate may have occurred making sample attrition an important limitation of the study. The providers of the dataset offer information on the response rate, which was approximately 68-79% at different sweeps (see table 5.1. in Chapter 5 for response rates by data collection sweep).

Findings of this thesis should be interpreted with caution as there could be possible selection bias due to missing data. Understanding the distribution of sample characteristics, for the omitted sample compared to the analytical samples, I chose to examine findings for the existing sample without imputing missing data. A number of observations were excluded because there were missing data on selected variables, specifically measures of psychosocial stressors, therefore analyses may underestimate the associations of psychosocial stressors with socioemotional difficulties and obesity.

In chapter 8, results for complete case analysis of cross-lagged paths between socioemotional difficulties and BMI were compared to analysis using full information maximum likelihood (FIML), which has been found to produce similar results to multiple imputation methods (Graham, 2003). Results for FIML showed similar bi-directional paths of association between socioemotional difficulties and BMI for girls in the complete case analysis. There were significant paths between BMI and SDQ score at age 7 and 11 but with comparatively smaller coefficients than for the complete case analysis.

9.3 Future directions of analysis

Contrary to the conceptual framework, there was little evidence found to suggest that the effect of stressors is moderated by health behaviours. However, they may be on the causal pathway between stressors with socioemotional difficulties and obesity, exerting risk or protective effects themselves. Future analysis could examine whether these health behaviours mediate relationships between stressors and children's health.

This thesis has advanced the understanding of how socioemotional well-being and BMI may pattern over time during the first decade of life. However, a greater understanding of the underlying mechanisms that result in girls with higher BMIs having increased mental health difficulties is needed. One possible question for research could be whether the correlation between BMI and mental health difficulties can be explained by the social stigma surrounding weight gain for young girls (Qualter et al., 2015). Further

analysis could investigate whether aspects of stigma or bullying contribute to this association throughout childhood and into adolescence.

With the benefit of hindsight gained from the final SEM chapter, if I were to perform the analysis again I might conduct multiple imputation to boost the power and reinforce findings of the longitudinal associations for stressors with socioemotional difficulties and obesity. However, I would expect to observe similar associations for stressors with socioemotional difficulties and obesity as that found for the complete case analysis. As shown in the analysis of the cross-lagged effects, associations for complete case and full information maximum likelihood analyses are often complementary (Mukaka et al., 2016, Graham, 2003).

The contextual factors of children's lives, measured by socioeconomic factors (SEP; parental education; and income quintile) were adjusted for in all empirical analysis chapters. However, only in cross-lagged models did I account for the element of temporal variability in these factors. Having learnt more about the impact of time-varying confounders, in future analysis I would explore the potential impact of measures of SEP at multiple time points throughout childhood.

9.4 Policy implications

The findings from this thesis sit within the wider UK socio-political context. The following section discusses some of the policy approaches taken so far to combat poor mental health and obesity in childhood, and subsequently highlights the policy implications from this thesis.

Since the Department for Health and the NHS published the Future in Mind report by the Children and Young People's Mental Health Taskforce in 2015, there has been a socio-political focus on children's mental health. What followed was the Five Year Forward View for Mental Health by the independent Mental Health Taskforce published in February 2016, which outlined a national strategy that covers care and support for all

ages; which is the first strategic approach to improving mental health outcomes across the health and care system (Mental Health Taskforce, 2016).

The NHS responded with an implementation plan, and the Department of Health has supported the delivery of this plan with a £1.2 billion investment. In December 2017, a green paper Transforming Children and Young People's Mental Health Provision was published by the government. This green paper puts schools and colleges at the centre of early intervention (Department for Health and Department for Education, 2017).

The partnership between education and health services is a positive move for improving early intervention for children showing signs of mental health difficulties. This thesis found that girls from as young as 7 years of age with higher BMI's were at greater risk of having mental health problems. Mental health support needs to target vulnerable girls. The data used in this study were collected at the beginning of the new century. Therefore, when study children were 11 years of age it was 2011/12, just after the social networking service Instagram was invented.

In recent years there has been an explosion of a photo and video sharing culture for young people, bringing with it an increase in the media presence of the 'body ideal' in the lives of children and young people. Some argue this has given rise to increased cyberbullying and a decrease in the well-being of adolescent girls (England, 2014). Using data from the Health Behaviour in School-aged Children (HBSC) study, a 2014 report by Public Health England found that girls were twice as likely as boys to report being cyberbullied (England, 2014).

Most recently, mental health has gained media attention after claims by the Association of Child Psychotherapists (ACP) that Child and Adolescent Mental Health Services (CAMHS) are failing to treat at-risk children (Association of Child Psychotherapists, 2018). This thesis has shown that there are various psychosocial determinants of mental health during childhood and pre-adolescence, which often originate within the family during formative years. Psychosocial stressors within the home are essentially

changeable and are open to intervention. For example, more support for the emotional health of parents could be one crucial intervention that could improve the psychosocial environment children are exposed to from a very early age. There are various arm's length bodies which can provide support for families, but a more holistic approach to the needs of parents and children should be considered. The improvement of mental health services for adults, as well as children, will have a knock-on effect to improve the family psychosocial environment in which children live. Policies challenging the inequalities in child health in the UK should take a comprehensive approach to understand the mechanisms which lead to socioemotional difficulties and childhood obesity.

In addition, this thesis found that associations between psychosocial stressors and childhood obesity were partly explained by measures of socioeconomic position (e.g. family occupational class and income). One driver of childhood obesity is the economic appeal of buying filling, energy-dense, cheap food (Drewnowski and Specter, 2004). Parents on a limited budget are induced to buy food that satiates hunger at as little cost as possible. To tackle one of the pathways to childhood obesity policy needs to combat child poverty.

There are economic barriers to living healthily and between 2007 and 2016, the cost of food increased by eight per cent (Department for Environment Food and Rural Affairs, 2015) whilst salaries also decreased (Office for National Statistics, 2018). In the 2005 Low Income Diet and Nutrition Survey, thirty-six per cent of respondents reported that they could not afford to eat balanced meals (Nelson et al., 2007); crucially this was before the economic recession.

This thesis has shown that children in households experiencing psychosocial stressors such as maternal depression and parental limiting longstanding illness are at greater risk of being obese. Food insecurity could have a further detrimental impact upon the health of children in these families. In 2013, an estimated 500,000 people relied on emergency food aid (Cooper and Dumpleton, 2013), and yet the number experiencing

food insecurity is likely to be much higher than those accessing food banks. Policymakers aiming to tackle childhood obesity need to focus on the wider social determinants of children's health. However, in an effort to combat population levels of overweight and obesity, the government has focused policies on diet and sugar intake, such as the taxation of high sugar products as part of the childhood obesity strategy published by the Government in January 2017 (HM Revenue & Customs, 2016, Public Health England, 2014).

These economically driven policies to combat obesity often hit disadvantaged people the most and focus too much on tackling individual health behaviour, rather than policies to tackle social determinants (Law et al., 2012). Previous commentators have argued that this emphasis on individual responsibility for health, rather than confronting the disadvantaged environments which shape family behavioural choices, should not be applied to childhood inequalities as the impact of government policies such as the 'Change4Life' social media campaign are often short-lived (Law et al., 2012, Parliamentary Office of Science & Technology, 2016).

9.5 Conclusion

This thesis has examined the cross-sectional and longitudinal associations between psychosocial stressors and both socioemotional difficulties and obesity in childhood and pre-adolescence. Children growing up in households characterised by psychosocial stressors were more likely to have socioemotional difficulties, and to a lesser extent were more likely to be obese. Psychosocial stressors can play a detrimental role in shaping children's mental and physical health.

Analysis of several health behaviours showed no evidence for effect modification of the relationship between stressors and socioemotional difficulties or obesity. A significant interaction was found for parent-child conflict and parental relationship status. Children in single-parent families, compared to other families types, were more likely to have socioemotional difficulties when exposed to parent-child conflict.

Findings from the analysis of the relationship between socioemotional difficulties and BMI across the first decade of life, showed a bi-directional association for girls. Evidence supports that preadolescent girls with socioemotional difficulties are more likely to have higher BMI's and similarly, girls with higher BMI's are at greater risk of socioemotional difficulties.

This thesis has demonstrated that as socioemotional difficulties and obesity often co-occur, especially in households characterised by certain psychosocial stressors, they should not be analysed in isolation of one another. Future studies looking to further understand the mechanisms which lead to socioemotional difficulties and childhood obesity should take into consideration the wider psychosocial environment in which children live.

Chapter 10: Appendices

Appendix 4

A4. 1 Psychological inventories

Table A4. 1 Strengths and Difficulties Questionnaire (socioemotional difficulties) scale

Item No.	Question
Emotional problems	
3	Complains of headaches/stomach aches/ sickness
8	Often seems worried
13	Often unhappy
16	Nervous or clingy in new situations
24	Many fears, easily scared
Conduct problems scale	
5	Often has temper tantrums
7	Generally obedient
12	Fights with or bullies other children
18	Often argumentative with adults
22	Can be spiteful to others
Hyperactivity scale	
2	Restless, overactive, cannot stay still long
10	Constantly fidgeting
15	Easily distracted
21	Can stop and think before acting
25	Sees tasks through to the end
Peer problems scale	
6	Tends to play alone
11	Has at least one good friend
14	Generally liked by other children
19	Picked on or bullied by other children
23	Gets on better with adults
Prosocial scale	
1	Considerate of others' feelings
4	Shares readily with others
9	Helpful if someone is hurt, upset or ill
17	Kind to younger children
20	Often volunteers to help others

Table A4. 2 Straus's Conflict tactics scale

Item no.	Question: How often do you do the following when CM is naughty
1	Ignore him/her/them
2	Smack him/her/them
3	Shout at him/her/them
4	Send him/her/them to his/her/their bedroom/naughty chair, etc.
5	Take away treats
6	Tell him/her/them off
7	Bribe him/her/them (e.g. with sweets, or a treat)

Table A4. 3 Kessler (K6) scale

Item no.	Question: During the last 30 days about how often did you feel…
1	…so depressed that nothing could cheer you up?
2	…hopeless?
3	…restless or fidgety?
4	…that everything was an effort?
5	…worthless?
6	…feel nervous?

A4. 2 Income data

Table A4. 4 Completeness of MCS banded household net income data (number of families)

Income data	MCS 1	MCS 2	MCS 3	MCS 4	MCS 5
Missing: refusal	482	439	673	510	1,346*
Missing: don't know	1,092	1,875	956	1,069	
Observed families	18,552	15,590	15,246	13,857	13,287

*Unable to differentiate refusals and don't knows at MCS5

Table A3. 1 Imputed Income Predictors

Variable	**Categories**
Main respondent's age at interview	Continuous variable
Housing tenure	Own Private renting Renting from Local Authority or Housing Association Other
DV combined labour market status of main and partner respondents	Both in work/on leave Main in work/on leave, partner not in work/on leave Partner in work/on leave, main not in work/on leave Both not in work/on leave Single-parent in work/on leave, Single-parent not in work/on leave
Point type	Advantaged Disadvantaged
DV interview government office region	North East North West Yorkshire and the Humber East Midlands West Midlands East of England London South East South West Wales Scotland Northern Ireland
Receipt of state benefit?	No Yes
Main respondent's ethnic group – 6 category census classification (UK)	White Mixed Indian Pakistani and Bangladeshi Black or Black British Other ethnic group (including Chinese and other Asian)

Table A4. 5 Imputed Income Predictors Continued

DV combined education highest NVQ	NVQ level 1 NVQ level 2 NVQ level 3 NVQ level 4 NVQ level 5 Overseas qualifications only None of these
Main type of accommodation	A house or bungalow A flat or maisonette A studio flat
Number of children including cohort child	1 2 3 4+
DV summary of parents/carers in household	Two parents/carers One parent/carer

*Both table A3.1 & A3.2 are adapted from (Centre for Longitudinal Studies, 2014).

Appendix 5

A5. 1 Sample size diagrams for cross-sectional analysis

Socioemotional difficulties

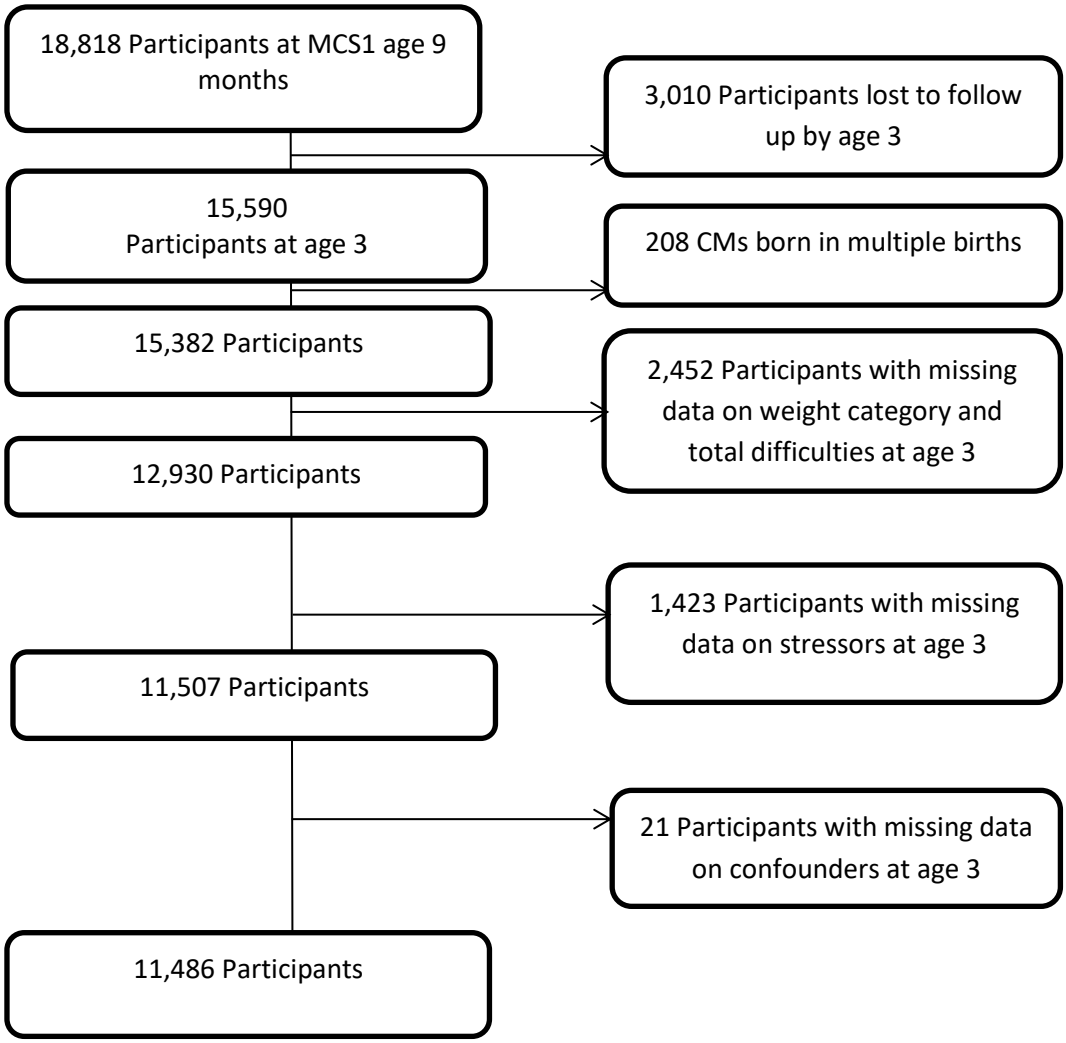

Figure A5. 1 Age 3 Socioemotional difficulties analysis sample

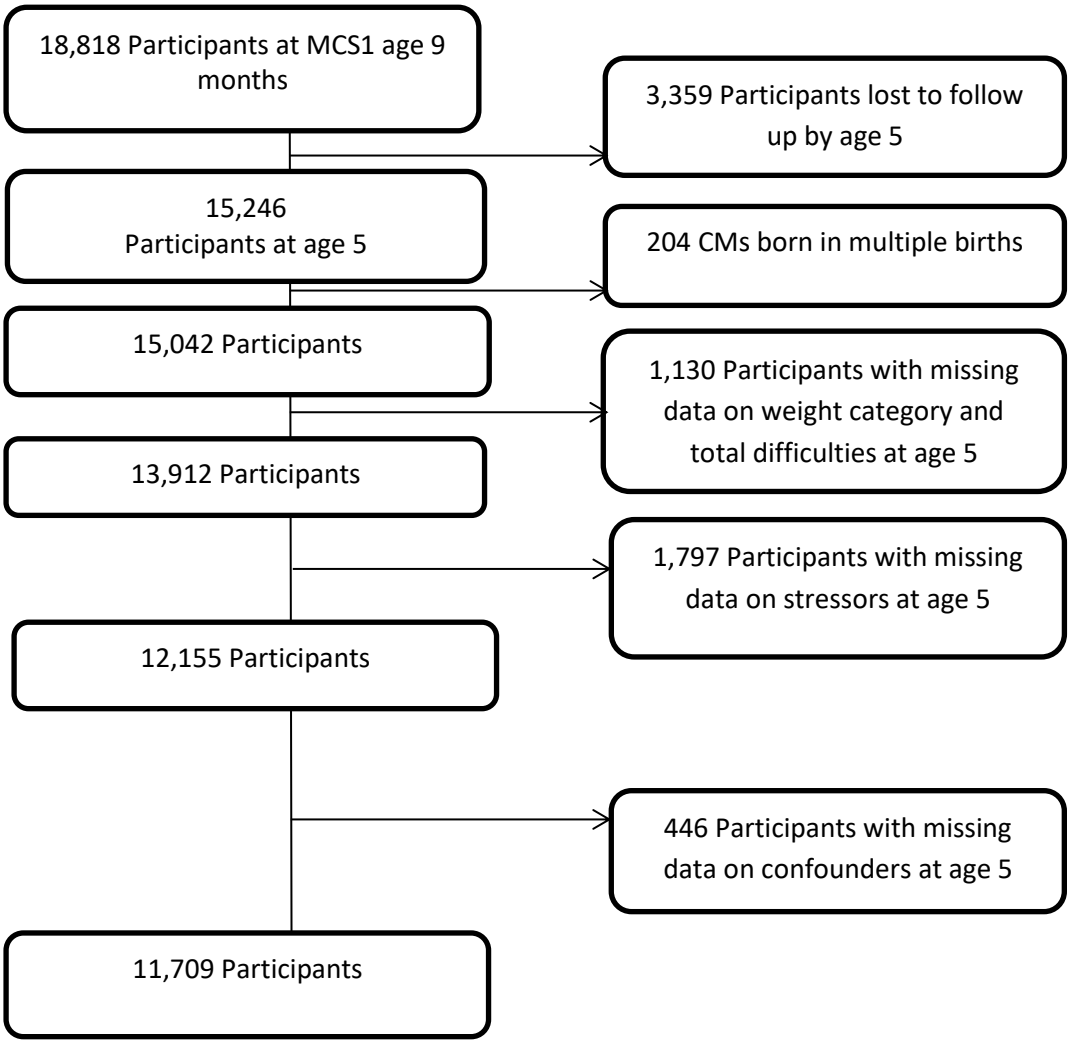

Figure A5. 2 Age 5 Socioemotional difficulties analysis sample

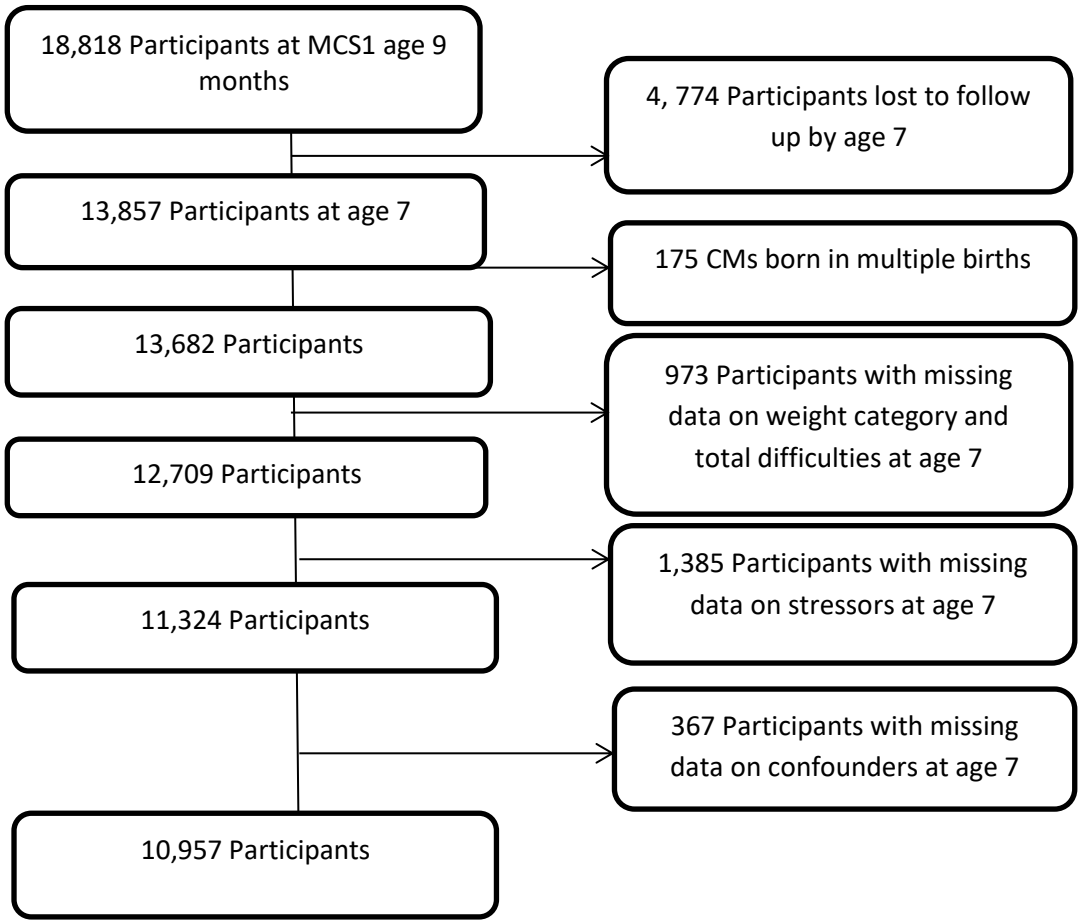

Figure A5. 3 Age 7 Socioemotional difficulties analysis sample

Obesity

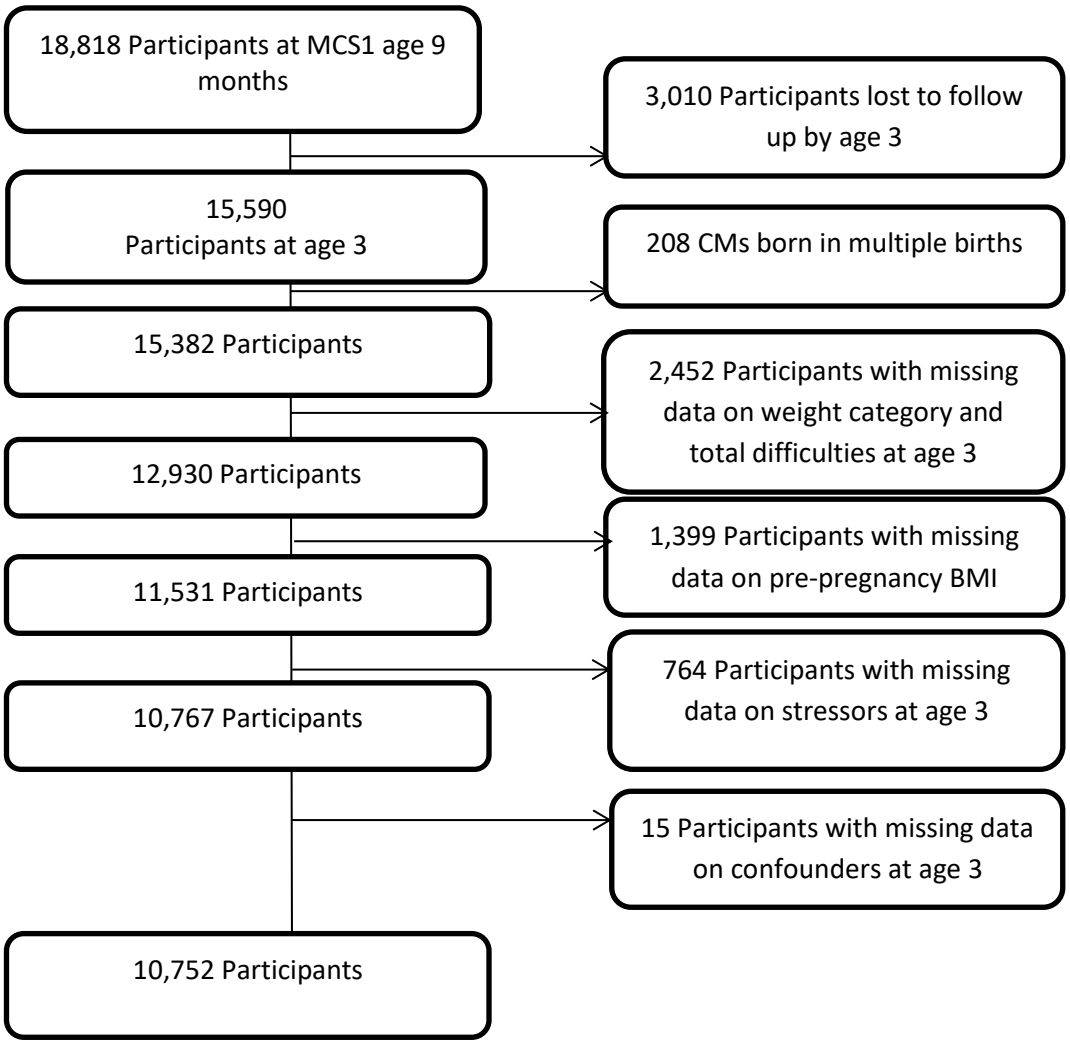

Figure A5. 1 Age 3 Obesity analysis sample

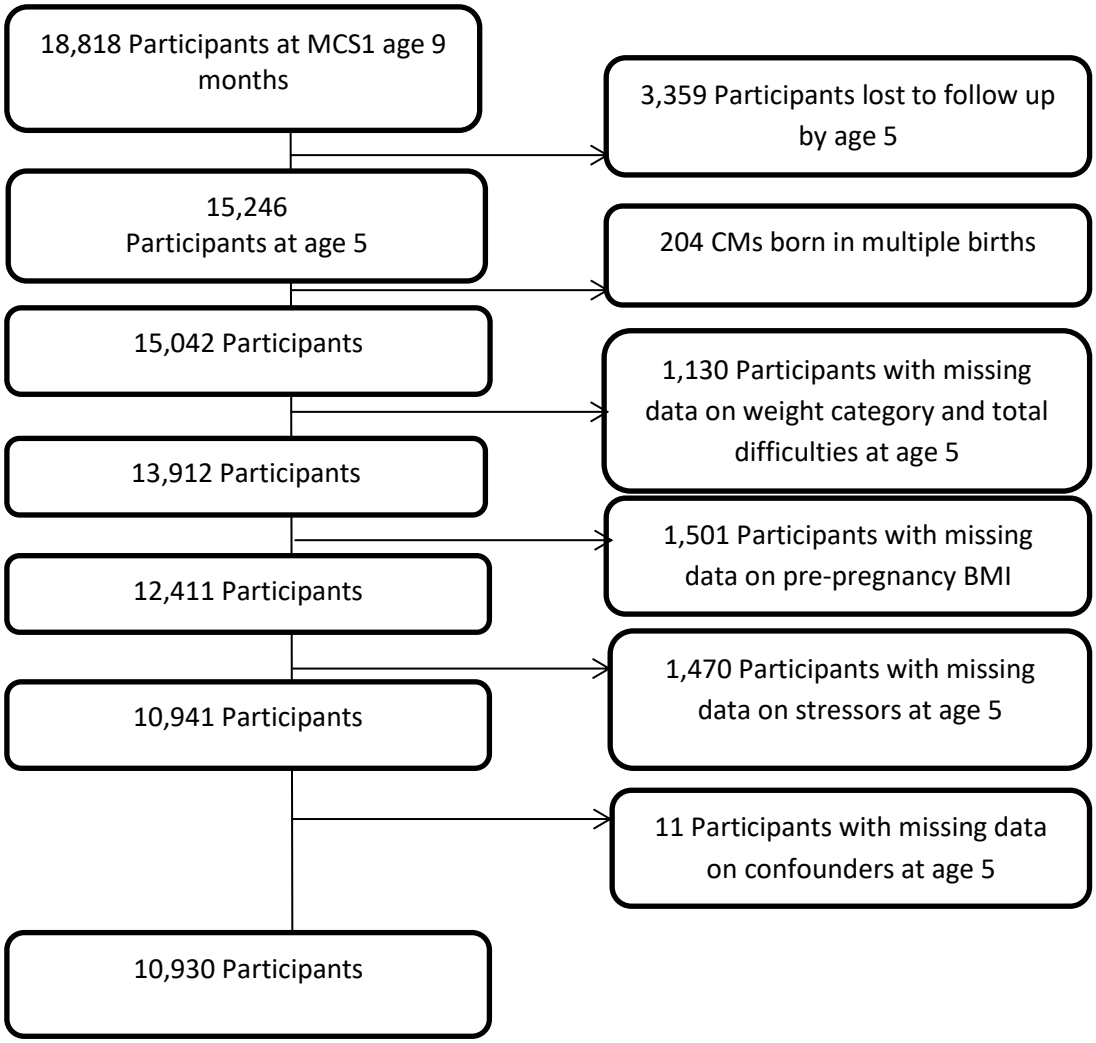

Figure A5. 4 Age 5 Obesity analysis sample

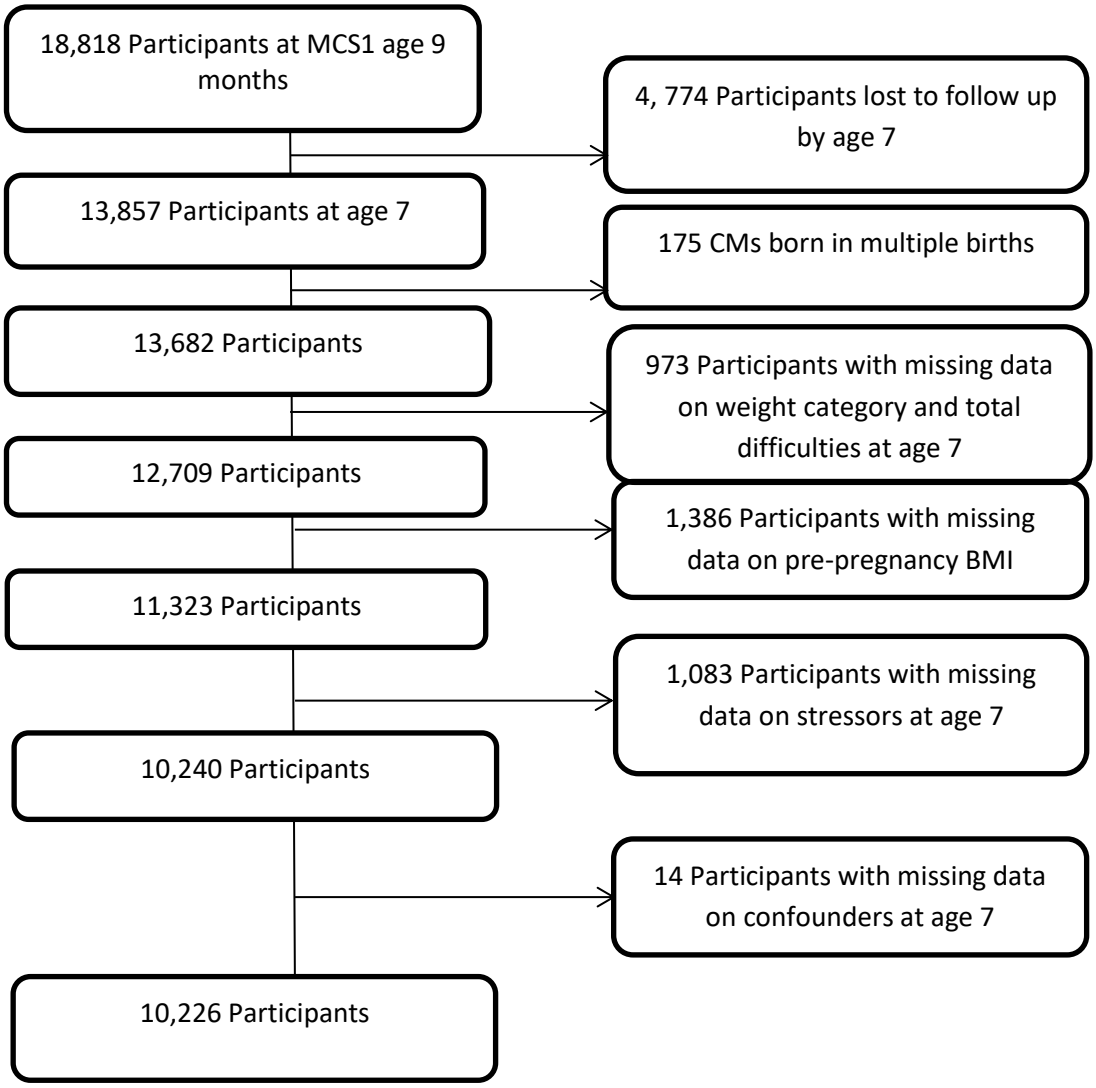

Figure A5. 5 Age 7 Obesity analysis sample

A5. 2 Descriptive analysis for cross-sectional samples

Table A5. 1 Distribution of high socioemotional difficulties by all other variables

	High socioemotional difficulties %			
Covariates	Age 3 (N=11,486)*	Age 5 (N=11,709)	Age 7 (N=10,957)	Age 11 (N=9,229)
Socioemotional Difficulties				
Low /Borderline		N/A		
High				
Weight Category				
Not obese	8.6	8.4	9.3	10.1
Obese	12.2	11.3	13.5	17.5
Sex				
Male	10.1	9.9	11.0	12.9
Female	7.5	7.2	8.1	8.0
Puberty Status				
Not begun		N/A		10.1
Has begun				13.3
Maternal smoking status				
Non-smoker	7.5	7.3	8.2	9.3
Smoked	14.0	14.0	15.1	15.6
Family socioeconomic characteristics				
Income Weighted Quintiles				
Highest quintile	2.6	3.3	3.5	4.9
Fourth quintile	4.3	5.0	5.3	6.4
Third quintile	7.7	7.4	9.4	8.6
Second quintile	13.3	13.0	12.6	17.1
Lowest quintile	19.2	19.2	19.5	18.8
Occupational class				
Managerial / professional	4.0	4.1	4.5	5.0
Intermediate	6.7	6.4	7.1	6.7
Small employers	8.0	5.2	6.0	8.7
Lower supervisory / technical	12.3	8.5	8.5	9.9
Semi-routine / routine	14.0	9.4	13.4	12.4
Unemployed / student	17.6	21.3	29.2	16.9
Education				
NVQ level 5	2.6	3.9	5.2	5.1
NVQ level 4	4.9	4.8	5.6	6.9
NVQ level 3	9.3	9.0	9.2	9.3
NVQ level 2	10.6	10.6	11.9	12.2
NVQ level 1	19.7	18.0	20.1	17.4
Overseas qualification only	24.5	27.0	19.4	12.0
None of these	22.8	30.4	27.2	21.5

Table A5. 2 Distribution of obesity by all other variables

Covariates	Obesity % Age 3 (N=10,752)	Age 5 (N=10,930)	Age 7 (N=10,226)	Age 11 (N=8,625)
Socioemotional Difficulties				
Normal /Borderline	5.0	4.9	5.1	5.6
Abnormal	5.5	7.0	6.9	10.2
Weight Category				
Not obese		N/A		
Obese				
Sex				
Male	5.0	4.6	4.6	5.9
Female	5.5	5.4	5.9	6.1
Puberty Status				
Not begun		N/A		5.4
Has begun				10.0
Maternal smoking status				
Non-smoker	5.0	4.7	4.9	5.1
Smoked	6.2	6.4	6.8	9.5
Family socioeconomic characteristics				
Income Weighted Quintiles				
Highest quintile	4.1	3.6	3.8	3.1
Fourth quintile	5.3	4.6	4.3	4.1
Third quintile	4.7	5.5	5.6	6.6
Second quintile	5.5	6.3	6.6	8.9
Lowest quintile	7.1	6.0	6.9	8.8
Occupational class				
Managerial / professional	4.4	3.8	3.9	3.8
Intermediate	5.1	5.7	5.0	4.7
Small employers	4.2	3.7	4.6	7.1
Lower supervisory / technical	4.8	5.8	5.7	9.1
Semi-routine and routine	7.4	5.6	6.1	6.6
Unemployed / student	6.6	7.0	8.8	8.0
Education				
NVQ level 5	4.0	3.0	3.3	2.7
NVQ level 4	4.7	4.2	4.4	4.4
NVQ level 3	5.5	5.8	5.8	4.7
NVQ level 2	5.6	5.6	6.3	6.8
NVQ level 1	6.6	8.5	6.5	8.4
Overseas qualification only	6.3	15.3	12.6	9.8
None of these	7.9	6.0	7.8	13.2

Table A5. 3 Descriptive Characteristics of Obesity Samples (weighted %)

	Obesity samples			
	Age 3 (N=10,752)*	Age 5 (N=10,930)	Age 7 (N=10,226)	Age 11 (N=8,625)
Categorical Variables	%(n)	% (n)	%(n)	%(n)
Outcomes				
Socioemotional difficulty scores				
Low /Borderline	91.5 (9,823)	91.6 (8,695)	90.7 (9,324)	89.7 (7,783)
High	8.5 (932)	8.3 (852)	9.3 (902)	10.3 (809)
Weight Category				
Not obese	94.8 (10,166)	95.0 (9,053)	94.7 (9,647)	94.0 (8,046)
Obese	5.2 (589)	5.0 (494)	5.3 (579)	6.0 (546)
Cohort member characteristics				
Sex				
Male	49.7 (5,365)	49.5 (4,750)	50.3 (5,096)	51.0 (4,307)
Female	50.3 (5,390)	50.5 (4,797)	49.7 (5,130)	49.0 (4,285)
Puberty Status				
Not begun	N/A	N/A	N/A	86.6 (7,455)
Has begun				13.3 (1,137)
Maternal smoking status				
Non-smoker	80.1 (8,559)	81.4 (7,718)	80.1 (8,251)	79.8 (6,965)
Smoker	19.9 (2,196)	18.6 (1,829)	19.9 (1,975)	20.2 (1,627)
Family socioeconomic characteristics				
Income Quintiles				
Highest quintile	22.8 (2,229)	24.5 (2,104)	22.9 (2,230)	23.3 (1,862)
Fourth quintile	22.1 (2,292)	22.8 (2,155)	22.1 (2,213)	22.0 (1,930)
Third quintile	20.8 (2,231)	21.8 (2,054)	20.5 (2,162)	21.0 (1,930)
Second quintile	18.1 (2,167)	17.7 (1,843)	17.9 (1,910)	18.7 (1,625)
Lowest quintile	16.1 (1,836)	13.1 (1,391)	16.5 (1,711)	14.8 (1,245)
Occupational class				
Managerial /professional	45.9 (4,736)	28.6 (2,562)	21.6 (2,231)	27.1 (2,549)
Intermediate	12.3 (1,339)	11.5 (1,073)	13.9 (1,362)	17.9 (1,535)
Small employers	6.7 (681)	14.0 (1,295)	13.5 (1,392)	6.5 (545)
Lower supervisory /technical	6.4 (706)	8.1 (817)	8.4 (893)	1.9 (171)
Semi-routine / routine	9.8 (1,162)	25.2 (2,504)	40.8 (4,177)	17.0 (1,411)
Unemployed / student	18.9 (2,131)	12.6 (1,296)	1.7 (171)	29.5 (2,381)

Table A5.3 (continued) Descriptive Characteristics of Obesity Samples (weighted %)

	Obesity samples			
	Age 3 (N=10,752)*	Age 5 (N=10,930)	Age 7 (N=10,226)	Age 11 (N=8,625)
Categorical Variables	%(n)	% (n)	%(n)	%(n)
Education				
NVQ level 5	7.9 (851)	11.5 (1,110)	12.8 (1,410)	12.3 (1,224)
NVQ level 4	39.8 (4,137)	41.1 (3,818)	38.0 (3,944)	32.1 (2,921)
NVQ level 3	16.9 (1,888)	16.3 (1,603)	16.2 (1,679)	8.7 (775)
NVQ level 2	24.4 (2,609)	22.2 (2,081)	22.5 (2,173)	30.4 (2,422)
NVQ level 1	4.8 (525)	4.1 (401)	4.3 (404)	7.0 (539)
Overseas qual. only	1.2 (147)	1.0 (117)	1.3 (138)	2.0 (155)
None of these	5.0 (598)	3.7 (414)	4.9 (478)	7.4 (556)
Stressors				
Limiting longstanding illness				
No	85.6 (9,138)	80.7 (7,639)	79.9 (8,156)	84.2 (7,206)
Yes	14.4 (1,617)	19.3 (1,907)	20.1 (2,070)	15.8 (1,386)
Parental relationship change				
No	89.3 (9,588)	89.9 (8,626)	93.2 (9,572)	86.3 (7,528)
Yes	10.7 (1,167)	10.1 (920)	6.8 (654)	13.7 (1,064)
High Conflict Tactics score				
No	69.7 (7,543)	88.9 (8,491)	89.7 (9,180)	61.6 (5,365)
Yes	30.3 (3,212)	11.1 (1,055)	10.3 (1,046)	38.4 (3,227)
High Kessler score				
No	97.2 (10,430)	97.4 (9,268)	96.7 (9,908)	94.7 (8,177)
Yes	2.7 (325)	2.7 (278)	3.3 (318)	5.3 (415)

**LLI at age 3 is taken from sweep one (9 months instead of 3 years)*

A5. 3 Externalising and internalising subscales for cross-sectional analysis of psychosocial stressors and socioemotional difficulties at repeated time points throughout childhood

A5.3 1 Externalising subscale

Table A5. 4 Odds ratios (95% CI) for multivariable logistic regression models showing the association between externalising socioemotional difficulties and limiting longstanding illness

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=11,797)				
No	Reference category			
Yes	1.46***	1.46***	1.29**	1.17
	1.25 - 1.71	1.24 - 1.70	1.10 - 1.50	0.98-1.38
Age 5 (N=11,829)				
No	Reference category			
Yes	1.42***	1.44***	1.31***	1.21*
	1.23 - 1.64	1.24 - 1.67	1.13 - 1.52	1.03 - 1.43
Age 7 (N=11,050)				
No	Reference category			
	1.33***	1.35***	1.25***	1.18*
Yes	1.19 - 1.49	1.20 - 1.51	1.11 - 1.40	1.04 - 1.34
Age 11 (N=9,246)				
No	Reference category			
Yes	1.84***	1.82***	1.56***	1.30*
	1.55 - 2.17	1.52 - 2.17	1.29 - 1.87	1.06 - 1.60

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 5 Odds ratios (95% CI) for multivariable logistic regression models showing the association between externalising socioemotional difficulties and relationship change

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=11,797)				
No	Reference category			
Yes	1.89***	1.32**	1.01	1.01
	1.59 – 2.25	1.10 - 1.58	0.84- 1.22	0.83-1.22
Age 5 (N=11,829)				
No	Reference category			
Yes	2.09***	1.69***	1.46***	1.35**
	1.76 – 2.49	1.41 - 2.02	1.23 - 1.74	1.11 - 1.63
Age 7 (N=11,050)				
No	Reference category			
	1.49***	1.26*	1.00	1.00
Yes	1.26 - 1.76	1.06 -1.51	0.83 - 1.21	0.82 - 1.22
Age 11 (N=9,246)				
No	Reference category			
Yes	1.57***	1.31**	1.13	1.25*
	5.85 – 7.92	1.08 - 1.59	0.93 – 1.38	1.01 - 1.56

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on relationship change
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 6 Odds ratios (95% CI) for multivariable logistic regression models showing the association between externalising socioemotional difficulties and parent-child conflict

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=11,797)				
No	Reference category			
Yes	3.73***	3.48***	3.80***	3.69***
	3.25 – 4.27	3.02 - 4.01	3.27- 4.40	3.18-4.28
Age 5 (N=11,829)				
No	Reference category			
Yes	5.41***	4.89***	5.41***	5.18***
	4.65 – 6.30	4.21-5.69	4.63-6.32	4.42– 6.08
Age 7 (N=11,050)				
No	Reference category			
	5.39***	4.94***	5.19***	5.10***
Yes	4.56-6.36	4.16 -5.87	4.36 – 6.19	4.27-6.09
Age 11 (N=9,246)				
No	Reference category			
Yes	6.81***	6.97***	6.20***	6.15***
	5.85 – 7.92	6.00 - 8.09	5.36 – 7.17	5.35- 7.06

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on parent-child conflict
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 7 Odds ratios (95% CI) for multivariable logistic regression models showing the association between externalising socioemotional difficulties and maternal depression

Age	Model 1	Model 2	Model 3	Model 4	Model 5
Age 3 (N=11,797)					
No	Reference category				
Yes	4.22***	3.76***	2.97***	2.58***	2.16***
	3.25 – 5.49	2.88-4.92	2.23- 3.95	1.90-3.51	1.57-2.97
Age 5 (N=11,829)					
No	Reference category				
Yes	4.19***	3.67***	2.80***	2.13***	1.74***
	3.29– 5.34	2.81-4.80	2.12-3.68	1.58– 2.87	1.27-2.38
Age 7 (N=11,050)					
No	Reference category				
	3.19***	2.83***	2.28***	1.97***	1.52**
Yes	2.48-4.11	2.18 –3.67	1.76 -2.96	1.49-2.60	1.13-2.05
Age 11 (N=9,246)					
No	Reference category				
Yes	3.89***	3.66***	2.73***	2.13***	1.52**
	3.06– 4.93	2.88- 4.65	2.12-3.50	1.62-2.80	1.12-2.08

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on maternal depression
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors
Model 5: Model 4 + internalising difficulties

A5.3 2 Internalising subscale

Table A5. 8 Odds ratios (95% CI) for multivariable logistic regression models showing the association between internalising socioemotional difficulties and limiting longstanding illness

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=11,797)				
No	Reference category			
Yes	1.41***	1.39***	1.26**	1.17
	1.19 - 1.66	1.18 - 1.65	1.07 - 1.50	0.98-1.40
Age 5 (N=11,829)				
No	Reference category			
Yes	1.52***	1.53***	1.39***	1.30***
	1.31 - 1.75	1.32 - 1.76	1.21 - 1.61	1.12 - 1.51
Age 7 (N=11,050)				
No	Reference category			
	1.48***	1.49***	1.37***	1.23*
Yes	1.27 - 1.73	1.27 - 1.74	1.17 - 1.60	1.05 - 1.44
Age 11 (N=9,246)				
No	Reference category			
Yes	1.99***	1.94***	1.70***	1.42***
	1.69 - 2.34	1.63 - 2.30	1.41 – 2.03	1.17 - 1.72

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 9 Odds ratios (95% CI) for multivariable logistic regression models showing the association between internalising socioemotional difficulties and relationship change

Age	Age	Model 1	Model 2	Model 3
Age 3 (N=11,797)				
No	Reference category			
Yes	1.36**	1.05	0.82*	0.81*
	1.13 – 1.63	0.87 - 1.27	0.67- 0.99	0.66-0.98
Age 5 (N=11,829)				
No	Reference category			
Yes	1.09	1.14	1.32**	1.54***
	0.91 – 1.29	0.96 -1.35	1.12 - 1.56	1.30 - 1.82
Age 7 (N=11,050)				
No	Reference category			
	1.57***	1.33*	1.00	1.01
Yes	1.26 - 1.97	1.05 -1.68	0.79 - 1.28	0.78 - 1.32
Age 11 (N=9,246)				
No	Reference category			
Yes	1.49***	1.32**	1.16	1.21
	1.24 – 1.79	1.08 - 1.61	0.95 – 1.42	0.99 - 1.49

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on relationship change
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 10 Odds ratios (95% CI) for multivariable logistic regression models showing the association between internalising socioemotional difficulties and parent-child conflict

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=11,797)				
No	Reference category			
Yes	1.68***	1.57***	1.63***	1.56***
	1.44 – 1.96	1.34-1.84	1.38- 1.92	1.31-1.84
Age 5 (N=11,829)				
No	Reference category			
Yes	1.98***	1.83***	1.93***	1.82***
	1.71 – 2.29	1.58-2.12	1.66-2.24	1.56– 2.13
Age 7 (N=11,050)				
No	Reference category			
	2.07***	2.21***	2.21***	2.43***
Yes	1.73-2.48	1.85 -2.64	1.86 – 2.63	2.04-6.09
Age 11 (N=9,246)				
No	Reference category			
Yes	2.70***	2.63***	2.76***	2.65***
	2.37 – 3.08	2.31- 2.99	2.41-3.15	2.31-3.04

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on parent-child conflict
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 11 Odds ratios (95% CI) for multivariable logistic regression models showing the association between internalising socioemotional difficulties and maternal depression

Age	Model 1	Model 2	Model 3	Model 4	Model 5
Age 3 (N=11,797)					
No	Reference category				
Yes	3.95***	3.56***	2.89***	2.68***	2.26***
	3.04 – 5.15	2.73-4.65	2.18- 3.81	2.02-3.55	1.68-3.04
Age 5 (N=11,829)					
No	Reference category				
Yes	4.26***	3.83***	2.93***	2.51***	2.25***
	3.32– 5.47	2.95-4.97	2.26-3.79	1.93– 3.27	1.71-2.97
Age 7 (N=11,050)					
No	Reference category				
	5.51***	4.84***	3.77***	3.34***	3.02***
Yes	4.22-7.19	3.70 –6.33	2.88- 4.95	2.54-4.40	2.26-4.03
Age 11 (N=9,246)					
No	Reference category				
Yes	5.13***	4.63***	3.63***	3.00***	2.65***
	3.94– 6.67	3.52-6.08	2.70-4.88	2.21-4.07	1.89-1.64

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on maternal depression
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors
Model 5: Model 4 + externalising difficulties

A5. 4 Maternal and paternal sensitivity analysis for cross-sectional analysis of LLI and socioemotional difficulties at repeated time points throughout childhood

Table A5. 12 Odds ratios (95% CI) for multivariable logistic regression models showing the association between socioemotional difficulties and maternal limiting longstanding illness

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=8,253)				
No	Reference category			
Yes	1.80***	1.70***	1.39***	1.23*
	1.39 -2.33	1.30-2.23	1.06 - 1.82	0.91-1.66
Age 5 (N=8,557)				
No	Reference category			
Yes	1.94***	1.93***	1.65***	1.40*
	1.56-2.40	1.55-2.41	1.31-2.10	1.07 - 1.85
Age 7 (N=7,431)				
No	Reference category			
	1.94***	1.85***	1.61***	1.47*
Yes	1.51 - 2.48	1.44-2.40	1.23-2.09	1.09-1.97
Age 11 (N=6,435)				
No	Reference category			
Yes	2.17***	2.14***	1.89***	1.53*
	1.64-2.89	1.60-2.88	1.40-2.56	1.08-2.16

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on maternal limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 13 Odds ratios (95% CI) for multivariable logistic regression models showing the association between socioemotional difficulties and paternal limiting longstanding illness

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=8,253)				
No	Reference category			
Yes	1.69***	1.60**	1.22	1.21
	1.26-2.27	1.20-2.15	0.91-1.63	0.88-1.65
Age 5 (N=8,557)				
No	Reference category			
Yes	1.45*	1.35*	1.05	0.94
	1.08-1.95	1.01-1.82	0.78-1.42	0.69-1.29
Age 7 (N=7,431)				
No	Reference category			
	1.69***	1.63**	1.34	1.25
Yes	1.25 - 2.29	1.20-2.22	0.99-1.80	0.90-1.73
Age 11 (N=6,435)				
No	Reference category			
Yes	2.27***	2.07***	1.66**	1.50*
	1.62-3.18	1.46-2.95	1.15-2.41	1.03-2.19

*** p<0.001, ** p<0.01, * p<0.05

Model 1: Socioemotional difficulties regressed on paternal limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

A5. 5 Maternal and paternal sensitivity analysis for cross-sectional analysis of depression and socioemotional difficulties at repeated time points throughout childhood

Table A5. 14 Odds ratios (95% CI) for multivariable logistic regression models showing the association between socioemotional difficulties and maternal depression

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=7,892)				
No	Reference category			
Yes	6.49***	5.65***	4.20***	3.65***
	4.53-9.30	3.89-8.20	2.87-6.16	2.42-5.51
Age 5 (N=8,387)				
No	Reference category			
Yes	6.14***	5.32***	4.08***	3.02***
	4.50-8.36	3.74-7.56	2.82-5.91	1.90-4.82
Age 7 (N=7,319)				
No	Reference category			
	4.96***	4.14***	3.43***	2.51***
Yes	3.15-7.82	2.57-6.68	2.12-5.56	1.47-4.28
Age 11 (N=6,257)				
No	Reference category			
Yes	5.71***	5.03***	4.15***	3.45***
	4.03-8.08	3.46-7.31	2.82-6.12	2.32-5.13

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on maternal depression
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 15 Odds ratios (95% CI) for multivariable logistic regression models showing the association between socioemotional difficulties and paternal depression

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=7,892)				
No	Reference category			
Yes	3.30***	2.98***	1.89*	1.78*
	2.00-5.46	1.75-5.06	1.12-3.19	1.04-3.03
Age 5 (N=8,387)				
No	Reference category			
Yes	2.34***	1.98**	1.26	1.11
	1.41-3.87	1.19-3.31	0.77-2.07	0.64-1.92
Age 7 (N=7,319)				
No	Reference category			
	3.48***	2.91***	2.12**	2.00*
Yes	2.16-5.61	1.74-4.89	1.25-3.59	1.15-3.46
Age 11 (N=6,257)				
No	Reference category			
Yes	2.32***	2.12**	1.67*	1.13
	1.48-3.65	1.34-3.37	1.04-2.67	0.68-1.87

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on paternal depression
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

A5. 6 Cross-sectional analysis of psychosocial stressors and teacher-rated socioemotional difficulties at ages 7 and 11 years.

Table A5. 16 Odds ratios (95% CI) for multivariable logistic regression models showing the association between teacher-rated socioemotional difficulties and relationship change

Age	Model 1	Model 2	Model 3	Model 4
Age 7 (N=7,213)				
No	Reference category			
Yes	1.19	1.21	1.14	1.09
	0.98-1.45	0.99-1.48	0.93-1.40	0.88-1.35
Age 11 (N=5,224)				
No	Reference category			
Yes	1.60***	1.56**	1.31	1.18
	1.23-2.07	1.19-2.04	0.99-1.73	0.89-1.57

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on relationship change
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 17 Odds ratios (95% CI) for multivariable logistic regression models showing the association between teacher-rated socioemotional difficulties and limiting longstanding illness

Age	Model 1	Model 2	Model 3	Model 4
Age 7 (N=7,213)				
No	Reference category			
Yes	1.58**	1.37	1.09	1.10
	1.17-2.13	1.00-1.87	0.78-1.53	0.78-1.54
Age 11 (N=5,224)				
No	Reference category			
Yes	1.15	0.93	0.80	0.86
	0.83-1.60	0.64-1.34	0.56-1.13	0.60-1.23

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 18 Odds ratios (95% CI) for multivariable logistic regression models showing the association between teacher-rated socioemotional difficulties and parent-child conflict

Age	Model 1	Model 2	Model 3	Model 4
Age 7 (N=7,213)				
No	Reference category			
Yes	2.36***	2.10***	2.08***	2.02***
	1.88-2.95	1.67-2.64	1.65-2.63	1.60-2.56
Age 11 (N=5,224)				
No	Reference category			
Yes	2.74***	2.60***	2.75***	2.67***
	2.18-3.45	2.06-3.29	2.19-3.46	2.12-3.37

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on parent-child conflict
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 19 Odds ratios (95% CI) for multivariable logistic regression models showing the association between teacher-rated socioemotional difficulties and maternal depression

Age	Model 1	Model 2	Model 3	Model 4
Age 7 (N=7,213)				
No	Reference category			
Yes	3.02***	2.73***	2.18***	1.97***
	2.04-4.47	1.82-4.08	1.46-3.25	1.31-2.95
Age 11 (N=5,224)				
No	Reference category			
Yes	2.84***	2.56***	1.66*	1.27
	1.78-4.53	1.62-4.04	1.04-2.64	0.78-2.06

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Socioemotional difficulties regressed on maternal depression
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

A5. 7 Maternal and paternal sensitivity analysis for cross-sectional analysis of limiting longstanding illness and childhood obesity at repeated time points throughout childhood

Table A5. 20 Odds ratios (95% CI) for multivariable logistic regression models showing the association of obesity and maternal limiting longstanding illness

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=7,808)				
No	Reference category			
Yes	0.73	0.63*	0.62*	0.64*
	0.49-1.11	0.41-0.98	0.40-0.97	0.41-0.99
Age 5 (N=8,031)				
No	Reference category			
Yes	1.18	1.02	1.00	0.99
	0.82-1.69	0.70-1.49	0.68-1.48	0.67-1.48
Age 7 (N=6,989)				
No	Reference category			
	1.11	0.91	0.83	0.81
Yes	0.79-1.57	0.63-1.33	0.56-1.21	0.55-1.20
Age 11 (N=6,036)				
No	Reference category			
Yes	1.41	1.11	0.86	0.84
	0.91-2.18	0.69-1.78	0.52-1.44	0.50-1.39

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Obesity regressed on maternal limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 21 Odds ratios (95% CI) for multivariable logistic regression models showing the association of obesity and paternal limiting longstanding illness

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=7,808)				
No	Reference category			
Yes	1.02	0.97	0.93	0.93
	0.60-1.73	0.57-1.65	0.56-1.54	0.56-1.53
Age 5 (N=8,031)				
No	Reference category			
Yes	1.37	1.25	1.23	1.21
	0.97-1.94	0.88-1.79	0.86-1.77	0.84-1.75
Age 7 (N=6,989)				
No	Reference category			
	1.61**	1.49*	1.32	1.31
Yes	1.13-2.31	1.03-2.14	0.92-1.88	0.91-1.88
Age 11 (N=6,036)				
No	Reference category			
Yes	1.80*	1.48	1.13	1.12
	1.13-2.88	0.89-2.44	0.68-1.90	0.66-1.91

*** p<0.001, ** p<0.01, * p<0.05
Model 1: Obesity regressed on paternal limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

A5. 8 Maternal and paternal sensitivity analysis for cross-sectional analysis of depression and childhood obesity at repeated time points throughout childhood

Table A5. 22 Odds ratios (95% CI) for multivariable logistic regression models showing the association of obesity and maternal depression

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=7, 450)				
No	Reference category			
Yes	0.76	0.61	0.61	0.62
	0.35-1.64	0.27-1.38	0.26-1.39	0.27-1.42
Age 5 (N=7,884)				
No	Reference category			
Yes	1.28	1.06	1.04	0.98
	0.63-2.60	0.51-2.19	0.49-2.19	0.46-2.10
Age 7 (N=6,891)				
No	Reference category			
	1.64	1.40	1.24	1.22
Yes	0.84 – 3.19	0.68-2.88	0.64- 2.41	0.62 -2.38
Age 11 (N=5,879)				
No	Reference category			
Yes	2.23*	1.52	1.14	1.16
	1.17-4.26	0.77-3.01	0.58-2.23	0.59-2.27

***p<0.001, ** p<0.01, * p<0.05
Model 1: Obesity regressed on maternal depression
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 23 Odds ratios (95% CI) for multivariable logistic regression models showing the association of obesity and paternal depression

Age	Model 1	Model 2	Model 3	Model 4
Age 3 (N=7, 450)				
No	Reference category			
Yes	0.65	0.55	0.51	0.52
	0.18-2.30	0.16-1.92	0.14-1.82	0.15-1.82
Age 5 (N=7,884)				
No	Reference category			
Yes	0.68	0.57	0.51	0.49
	0.23-1.98	0.20-1.64	0.17-1.51	0.16-1.44
Age 7 (N=6,891)				
No	Reference category			
	0.96	0.71	0.51	0.48
Yes	0.41-2.26	0.29-1.73	0.19-1.35	0.18-1.29
Age 11 (N=5,879)				
No	Reference category			
Yes	2.14*	1.76	1.35	1.39
	1.16-3.95	0.92-3.37	0.67-2.73	0.70-2.79

***p<0.001, ** p<0.01, * p<0.05
Model 1: Obesity regressed on maternal depression
Model 2: Model 1 + CM and paternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

A5. 9 Sensitivity analysis for cross-sectional analysis of psychosocial stressors and weight status at repeated time points throughout childhood

Table A5. 24 Relative risk ratios (95% CI) for multivariable multinomial regression models showing the conditional association between parental limiting longstanding illness with overweight and obesity

	Model 1 95% CI		Model 2 95% CI		Model 3 95% CI		Model 4 95% CI	
Age	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
Age 3 (N=10,752)								
No	Reference category							
Yes	0.86	0.84	0.83*	0.73	0.83*	0.68*	0.84	0.70*
	0.73 – 1.02	0.60 – 1.16	0.70 – 0.99	0.51 – 1.02	0.69 – 0.99	0.48 – 0.97	0.70 – 1.01	0.49 – 0.99
Age 5 (N=10,930)								
No	Reference category							
Yes	1.01	1.27*	0.93	1.10	0.93	1.08	0.93	1.10
	0.87 – 1.17	1.01 – 1.61	0.79 – 1.08	0.87 – 1.40	0.79 – 1.08	0.84 – 1.38	0.80 – 1.09	0.86 – 1.41
Age 7 (N=10,226)								
No	Reference category							
	1.17*	1.39**	1.08	1.17	1.07	1.11	1.08	1.11
Yes	1.01 – 1.36	1.08 – 1.78	0.93 – 1.25	0.90 – 1.52	0.92 – 1.24	0.86 – 1.44	0.93 – 1.25	0.86 – 1.44
Age 11 (N=8,625)								
No	Reference category							
Yes	1.24*	1.48**	1.13	1.16	1.09	0.94	1.08	0.88
	1.03 – 1.49	1.12 – 1.96	0.94 – 1.35	0.85 – 1.58	0.90 – 1.31	0.68 – 1.30	0.90 – 1.30	0.64 – 1.23

*** p<0.001, ** p<0.01, * p<0.050
Model 1: Weight status regressed on limiting longstanding illness
Model 2: Model 1 + CM and maternal characteristics
Model 3: Model 2 + family socioeconomic characteristics
Model 4: Model 3 + other stressors

Table A5. 25 Relative risk ratios (95% CI) for multivariable multinomial regression models showing the conditional association between parental relationship change with overweight and obesity

	Model 1 95% CI		Model 2 95% CI		Model 3 95% CI		Model 4 95% CI	
Age	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
Age 3 (N=10,752)								
No	Reference category							
Yes	1.09	1.11	1.09	1.09	1.09	0.93	1.10	0.94
	0.91 – 1.30	0.80 – 1.53	0.91 – 1.32	0.77 – 1.53	0.90 – 1.33	0.65 – 1.32	0.90 – 1.33	0.66 – 1.33
Age 5 (N=10,930)								
No	Reference category							
Yes	1.05	1.23	1.02	1.17	1.01	1.08	1.02	1.08
	0.86 – 1.28	0.91 – 1.66	0.83 – 1.25	0.85 – 1.60	0.82 – 1.25	0.78 – 1.49	0.83 – 1.25	0.78 – 1.49
Age 7 (N=10,226)								
No	Reference category							
	1.33*	1.14	1.33*	1.13	1.31*	0.98	1.32*	0.98
Yes	1.04 – 1.69	0.77 – 1.68	1.04 – 1.70	0.76 – 1.66	1.02 – 1.68	0.67 – 1.42	1.21 - 1.75	0.67 – 1.44
Age 11 (N=8,625)								
No	Reference category							
Yes	1.05	1.22	1.03	1.10	0.97	0.96	0.98	0.95
	0.86 – 1.28	0.91 – 1.64	0.84 – 1.26	0.80 – 1.51	0.79 – 1.20	0.69 – 1.32	0.79 – 1.21	0.69 – 1.31

*** p<0.001, ** p<0.01, * p<0.05

Model 1: Weight status regressed on limiting longstanding illness

Model 2: Model 1 + CM and maternal characteristics

Model 3: Model 2 + family socioeconomic characteristics

Model 4: Model 3 + other stressors

Table A5. 26 Relative risk ratios (95% CI) for multivariable multinomial regression models showing the conditional association between parent-child conflict with overweight and obesity

	Model 1 95% CI		Model 2 95% CI		Model 3 95% CI		Model 4 95% CI	
Age	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
Age 3 (N=10,752)								
No	Reference category							
Yes	1.06	1.08	1.04	1.02	1.05	1.05	1.06	1.06
	0.90 – 1.24	0.79 – 1.48	0.89 – 1.22	0.75 – 1.38	0.90 – 1.23	0.77 – 1.42	0.91 – 1.25	0.78 – 1.45
Age 5 (N=10,930)								
No	Reference category							
Yes	0.89	1.25	0.82	1.14	0.83	1.19	0.83	1.20
	0.74 – 1.07	0.93 – 1.69	0.67 – 1.00	0.85 – 1.53	0.68 – 1.01	0.88 – 1.60	0.68 – 1.01	0.89 – 1.61
Age 7 (N=10,226)								
No	Reference category							
	0.88	0.91	0.87	0.86	0.86	0.88	0.86	0.88
Yes	0.71 – 1.11	0.66 – 1.25	0.69 – 1.09	0.62 – 1.21	0.68 – 1.08	0.63 – 1.23	0.68 – 1.08	0.63 – 1.23
Age 11 (N=8,625)								
No	Reference category							
Yes	1.18**	1.15	1.13	0.91	1.15*	0.99	1.14*	0.98
	1.04 – 1.34	0.93 – 1.42	0.99 – 1.29	0.71 – 1.18	1.00 – 1.31	0.76 – 1.28	1.00 – 1.31	0.76 – 1.27

*** p<0.001, ** p<0.01, * p<0.05

Model 1: Weight status regressed on limiting longstanding illness

Model 2: Model 1 + CM and maternal characteristics

Model 3: Model 2 + family socioeconomic characteristics

Model 4: Model 3 + other stressors

Table A5. 27 Relative risk ratios (95% CI) for multivariable multinomial regression models showing the conditional association between maternal depression with overweight and obesity

	Model 1 95% CI		Model 2 95% CI		Model 3 95% CI		Model 4 95% CI	
Age	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity	Overweight	Obesity
Age 3 (N=10,752)								
No	Reference category							
Yes	0.67*	0.85	0.64*	0.66	0.63*	0.60	0.64*	0.64
	0.46 – 0.98	0.46 – 1.56	0.44 – 0.94	0.35 – 1.26	0.43 – 0.92	0.31 – 1.15	0.44 – 0.95	0.33 – 1.23
Age 5 (N=10,930)								
No	Reference category							
Yes	1.07	0.87	0.92	0.69	0.90	0.62	0.93	0.59
	0.74 – 1.55	0.50 – 1.50	0.63 – 1.35	0.38 – 1.24	0.61 – 1.33	0.34 – 1.12	0.63 – 1.38	0.33 – 1.07
Age 7 (N=10,226)								
No	Reference category							
	1.14	1.41	1.05	1.18	1.03	1.04	1.01	1.02
Yes	0.78 – 1.66	0.86 – 2.31	0.71 – 1.55	0.70 – 2.00	0.69 – 1.52	0.62 – 1.74	0.68 – 1.51	0.61 – 1.70
Age 11 (N=8,625)								
No	Reference category							
Yes	1.18	2.95***	1.09	2.26***	1.00	1.56*	0.97	1.61*
	0.85 – 1.63	1.97 – 4.43	0.79 – 1.52	1.49 – 3.43	0.72 – 1.40	1.04 – 2.36	0.70 – 1.36	1.07 – 2.43

*** p<0.001, ** p<0.01, * p<0.05

Model 1: Weight status regressed on limiting longstanding illness

Model 2: Model 1 + CM and maternal characteristics

Model 3: Model 2 + family socioeconomic characteristics

Model 4: Model 3 + other stressors

Appendix 6

A6. 1 Externalising and internalising subscales for longitudinal analysis of psychosocial stressors and socioemotional difficulties

Table A6. 1 Odds ratios (95% CI) for multivariable logistic regression models showing the association of externalising socioemotional difficulties at age 11 years and longitudinal stressors

Stressors (N=7,810)	Model 1	Model 2	Model 3	Model 4
Limiting longstanding illness				
Never	Reference category			
Past	0.98	1.00	1.01	0.99
	0.71-1.35	0.73-1.37	0.74-1.39	0.71-1.37
Present	1.67**	1.48*	1.43	1.18
	1.22-2.28	1.01-2.16	0.93-2.10	0.79-1.78
Past	1.83***	1.65***	1.56***	1.39***
&Present	1.56-2.14	1.39-1.96	1.31-1.85	1.16-1.68
Relationship change				
Never	Reference category			
Past	1.88***	1.47*	1.36	1.42
	1.36-2.60	1.01-2.13	0.93-1.99	0.93-2.16
Present	1.81***	1.55**	1.48**	1.52**
	1.41-2.33	1.19-2.04	1.13-1.94	1.16-1.99
Past	2.26***	1.58***	1.40**	1.30*
&Present	1.91-2.69	1.30-1.93	1.16-1.70	1.06-1.60
Parent-child conflict				
Never	Reference category			
Past	1.67	1.20	1.19	0.96
	0.73-3.83	0.49-2.96	0.49-2.89	0.33-2.77
Present	5.08***	4.88***	5.04***	4.99***
	4.11-6.28	3.92-6.06	4.04-6.28	3.98-6.25
Past	5.73***	4.27***	4.63***	4.47***
&Present	4.70-7.00	3.47-5.26	3.76-5.70	3.63-5.50
Maternal depression				
Never	Reference category			
Past	3.54***	3.13***	2.74***	2.69***
	2.22-5.63	1.86-5.27	1.63-4.61	1.50-4.83
Present	4.43***	3.65***	3.33***	2.80***
	3.29-5.95	2.61-5.12	2.38-4.66	2.00-3.92
Past	3.55***	2.27***	2.03***	1.53***
&Present	2.74-4.60	1.70-3.05	1.52-2.71	1.11-2.11

*** p<0.001, ** p<0.01, * p<0.05

Model 1: Socioemotional difficulties regressed on stressors (limiting longstanding illness; relationship change; parent-child conflict; maternal depression)

Model 2: Model 1 + CM and maternal characteristics

Model 3: Model 2 + family socioeconomic characteristics

Model 4: Model 3 + other stressors

Table A6. 2 Odds ratios (95% CI) for multivariable logistic regression models showing the association of internalising socioemotional difficulties at age 11 years and longitudinal stressors

Stressors (N=7,810)	Model 1	Model 2	Model 3	Model 4
Limiting longstanding illness				
Never	Reference category			
Past	1.00	1.01	1.01	1.00
	0.71-1.40	0.72-1.43	0.72-1.43	0.70-1.43
Present	2.22***	2.06***	1.96***	1.71**
	1.66-2.26	1.51-2.80	1.43-2.68	1.23-2.36
Past	1.89***	1.68***	1.58***	1.41***
&Present	1.63-2.18	1.45-1.95	1.36-1.84	1.20-1.66
Relationship change				
Never	Reference category			
Past	2.24***	1.86**	1.73**	1.75**
	1.55-3.25	1.26-2.75	1.17-2.57	1.16-2.62
Present	1.80***	1.59***	1.51**	1.49**
	1.43-2.27	1.23-2.04	1.17-1.95	1.14-1.94
Past	1.73***	1.30***	1.15	1.05
&Present	1.43-2.09	1.05-1.62	0.92-1.43	0.83-1.32
Parent-child conflict				
Never	Reference category			
Past	1.42	1.21	1.16	0.99
	0.74-2.74	0.64-2.30	0.62-2.18	0.49-1.98
Present	2.30***	2.11***	2.15***	2.12***
	1.91-2.78	1.74-2.56	1.77-2.62	1.73-2.58
Past	2.62***	2.05***	2.17***	2.07***
&Present	2.25-3.05	1.76-2.39	1.86-2.55	1.76-2.42
Maternal depression				
Never	Reference category			
Past	3.09***	2.70***	2.35***	2.21***
	2.04-4.67	1.77-4.11	1.53-3.61	1.44-3.39
Present	4.23***	3.32***	3.04***	2.57***
	2.95-6.06	2.29-4.80	2.10-4.40	1.76-3.76
Past	3.75***	2.58***	2.29***	1.88***
&Present	2.81-5.00	1.86-3.58	1.67-3.15	1.33-2.64

*** p<0.001, ** p<0.01, * p<0.05

Model 1: Socioemotional difficulties regressed on stressors (limiting longstanding illness; relationship change; parent-child conflict; maternal depression)

Model 2: Model 1 + CM and maternal characteristics

Model 3: Model 2 + family socioeconomic characteristics

Model 4: Model 3 + other stressors

A6. 2 Sensivity analysis of longitudinal analysis of psychosocial stressors and weight status

Table A6. 3 Relative risk ratios (95% CI) for multinomial regression models showing the associations between longitudinal stressors and obesity at age 11 years (Never exposed as reference category) (N=7,017)

		Model 1 95% CI		Model 2 95% CI		Model 3 95% CI		Model 4 95% CI	
		Overweight	Obese	Overweight	Obese	Overweight	Obese	Overweight	Obese
Limiting longstanding illness	Past	1.47**	1.09	1.44*	0.95	1.41*	0.91	1.44*	0.91
		1.10 – 1.96	0.64 – 1.87	1.07 – 1.94	0.51 – 1.77	1.05 – 1.90	0.47 – 1.73	1.07 – 1.93	0.48 – 1.73
	Present	1.06	0.76	1.00	0.65	0.96	0.57	0.97	0.54
		0.71 – 1.59	0.64 – 1.87	0.66 – 1.50	0.29 – 1.46	0.64 – 1.44	0.25 – 1.26	0.65 – 1.46	0.24 – 1.23
	Past &Present	1.28**	1.84***	1.13	1.34*	1.08	1.19	1.10	1.14
		1.09 – 1.50	1.39 – 2.43	0.95 – 1.33	1.00 – 1.80	0.91 – 1.28	0.88 – 1.60	0.92 – 1.30	0.85 – 1.53
Relationship change	Past	1.46	2.47***	1.39	2.24*	1.32	2.07*	1.35	2.04*
		0.97 – 2.19	1.45 – 4.22	0.92 – 2.11	1.17 – 4.28	0.87 – 2.00	1.11 – 3.86	0.90 – 2.04	1.09 – 3.81
	Present	1.09	1.42	1.06	1.36	1.02	1.30	1.03	1.28
		0.81 – 1.46	0.96 – 2.12	0.78 – 1.44	0.86 – 2.15	0.75 – 1.39	0.83 – 2.05	0.76 – 1.39	0.81 – 2.00
	Past &Present	1.24*	1.34	1.24*	1.23	1.15	0.98	1.16	0.96
		1.04 – 1.47	0.99 – 1.82	1.02 – 1.50	0.90 – 1.68	0.93 – 1.41	0.70 – 1.36	0.94 – 1.42	0.68 – 1.35
Parent-child conflict	Past	0.95	1.35	0.88	1.51	0.90	1.57	0.89	1.49
		0.47 – 1.91	0.39 – 4.69	0.42 – 1.83	0.41 – 5.48	0.44 – 1.85	0.44 – 5.56	0.43 – 1.85	0.45 – 4.93
	Present	1.12	1.12	1.07	0.99	1.07	1.03	1.08	1.05
		0.94 – 1.34	0.82 – 1.55	0.89 – 1.28	0.69 – 1.41	0.89 – 1.29	0.71 – 1.48	0.90 – 1.30	0.73 – 1.52
	Past &Present	0.99	1.18	1.07	1.07	0.98	1.17	0.99	1.15
		0.84 – 1.16	0.89 – 1.56	0.81 – 1.16	0.79 – 1.44	0.82 – 1.18	0.87 – 1.58	0.82 – 1.18	0.85 – 1.57
Maternal depression	Past	0.61	1.78	0.64	1.73	0.60	1.61	0.57	1.56
		0.31 – 1.18	0.77 – 4.13	0.33 – 1.26	0.67 – 4.58	0.31 – 1.18	0.60 – 4.27	0.30 – 1.10	0.57 – 4.24
	Present	1.09	2.55**	1.00	1.71	0.92	1.21	0.91	1.20
		0.68 – 1.76	1.30 – 5.00	0.59 – 1.68	0.95 – 3.07	0.67 - 2.14	0.66 – 2.21	0.55 – 1.50	0.64 – 2.26
	Past &Present	0.99	1.97**	0.90	1.52	0.81	1.17	0.78	1.10
		0.70 – 1.40	1.27 – 3.06	0.63 – 1.30	0.90 – 2.56	0.56 – 1.17	0.70 – 1.95	0.54 – 1.13	0.67 – 1.82

*** p<0.001, ** p<0.01, * p<0.05 Model 1: Weight status regressed on stressor (limiting longstanding illness; relationship change; parent-child conflict; or maternal depression) Model 2: Model 1 + cohort member (CM) and maternal characteristics Model 3: Model 2 + baseline family socioeconomic characteristics Model 4: Model 3 + other longitudinal stressors

Appendix 8

A8. 1 Subscales for cross-lagged effects model of BMI and socioemotional difficulties

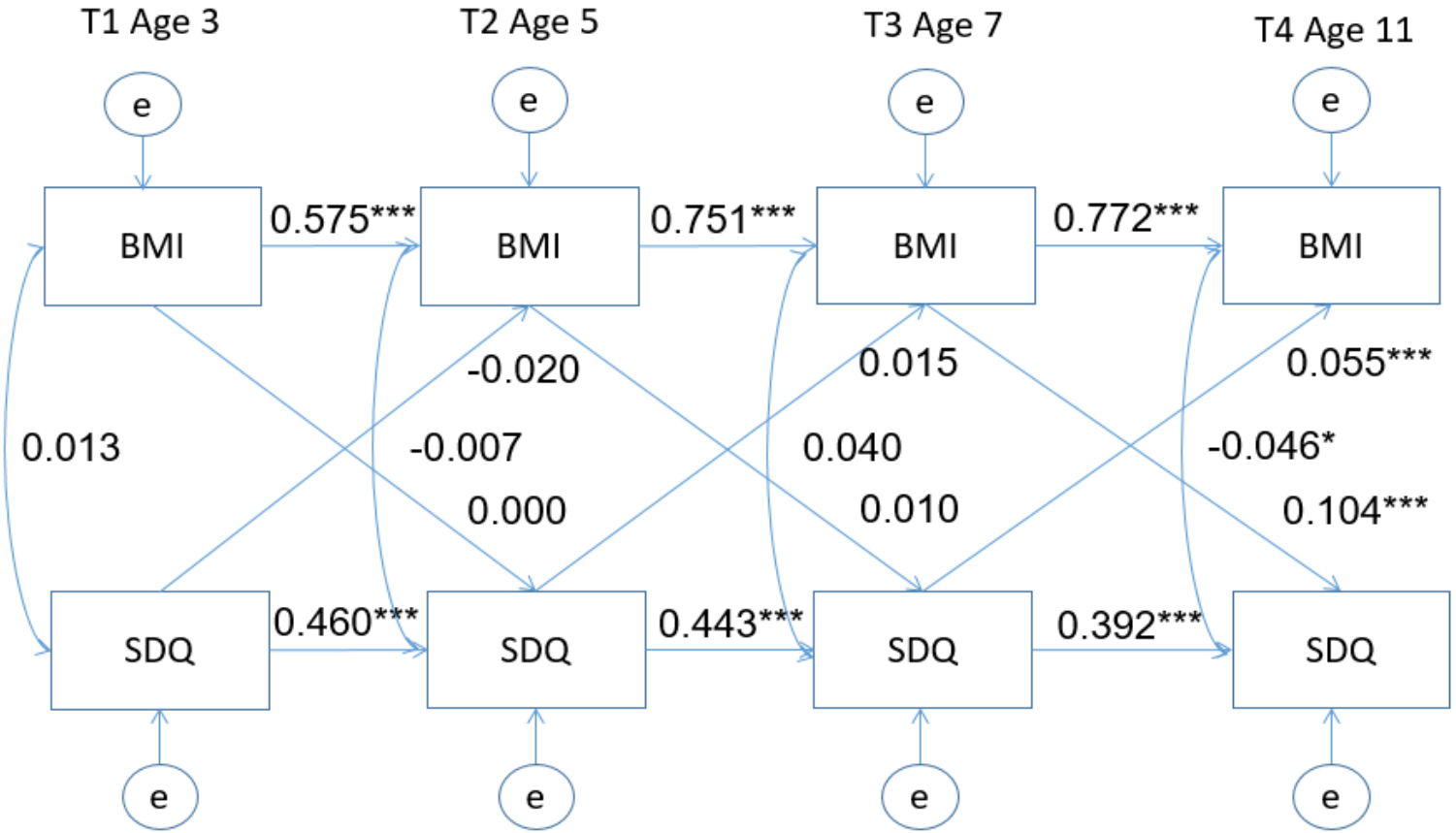

Figure A8. 1 Girls longitudinal cross-lagged effects model of BMI and internalising SDQ score fully adjusted for covariates and psychosocial stressors (n=3,325)

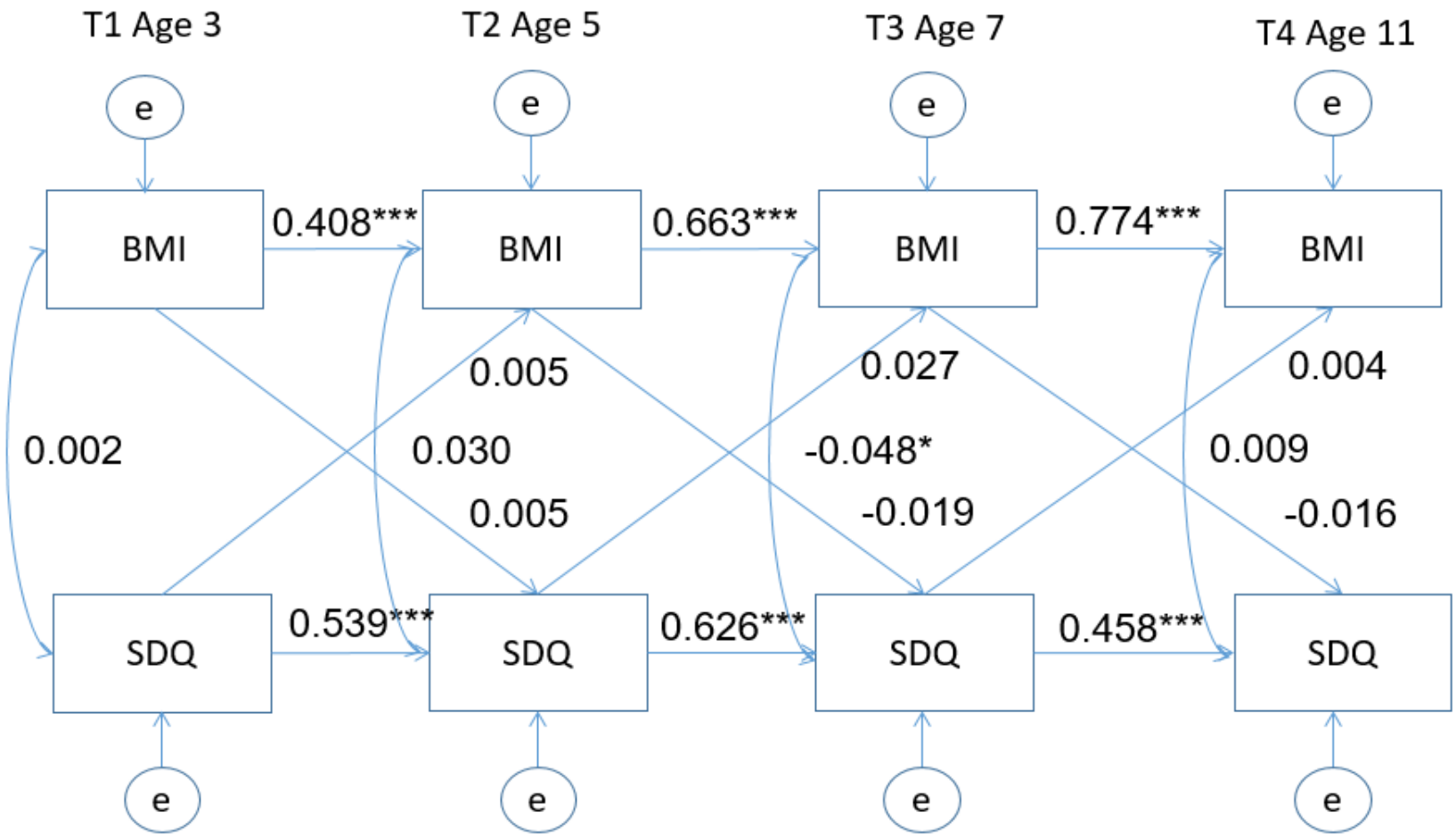

Figure A8. 2 Boys longitudinal cross-lagged effects model of BMI and internalising SDQ score fully adjusted for covariates and psychosocial stressors (n=3,254)

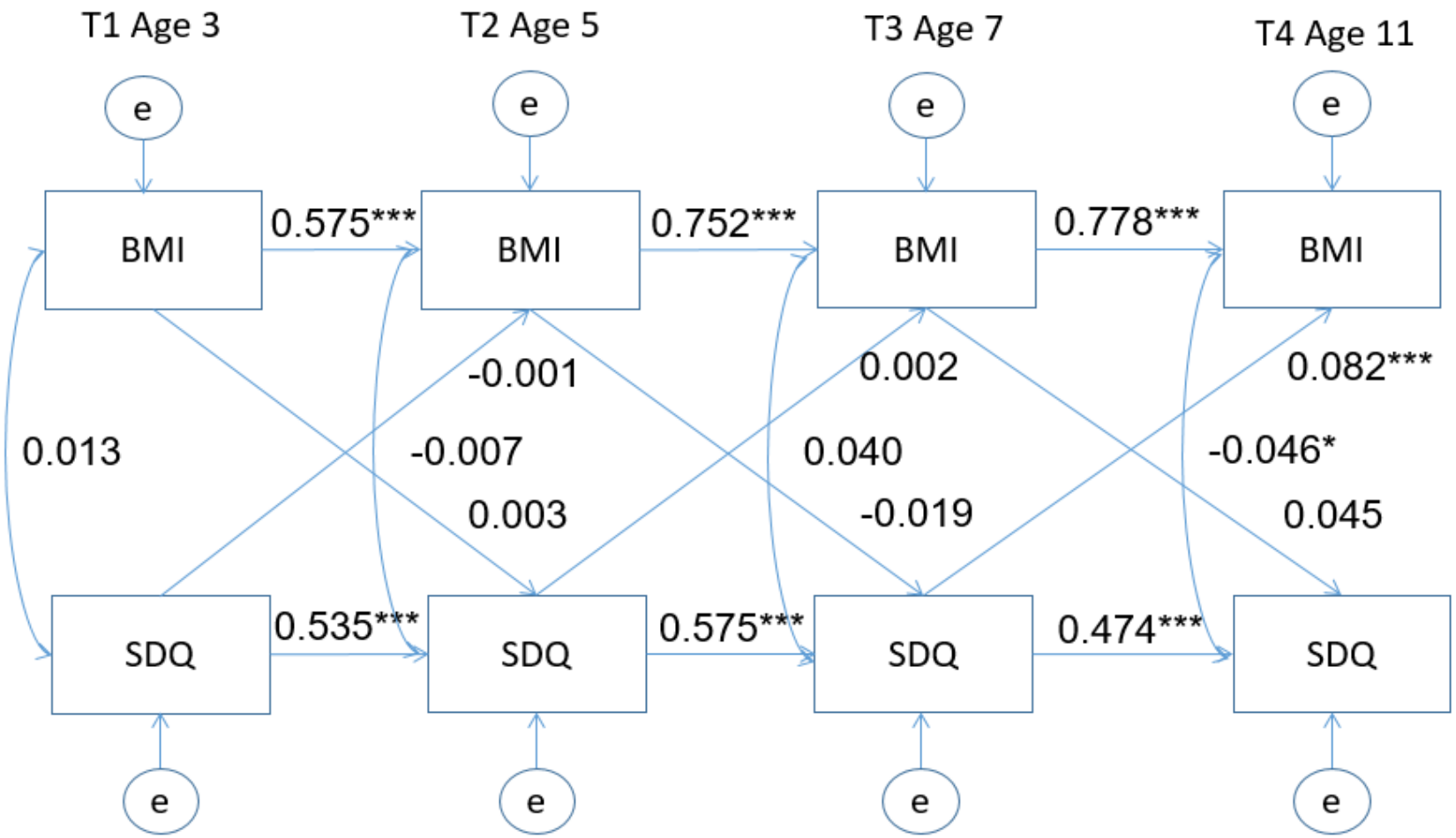

Figure A8. 3 Girls longitudinal cross-lagged effects model of BMI and externalising SDQ score fully adjusted for covariates and psychosocial stressors (n=3,325)

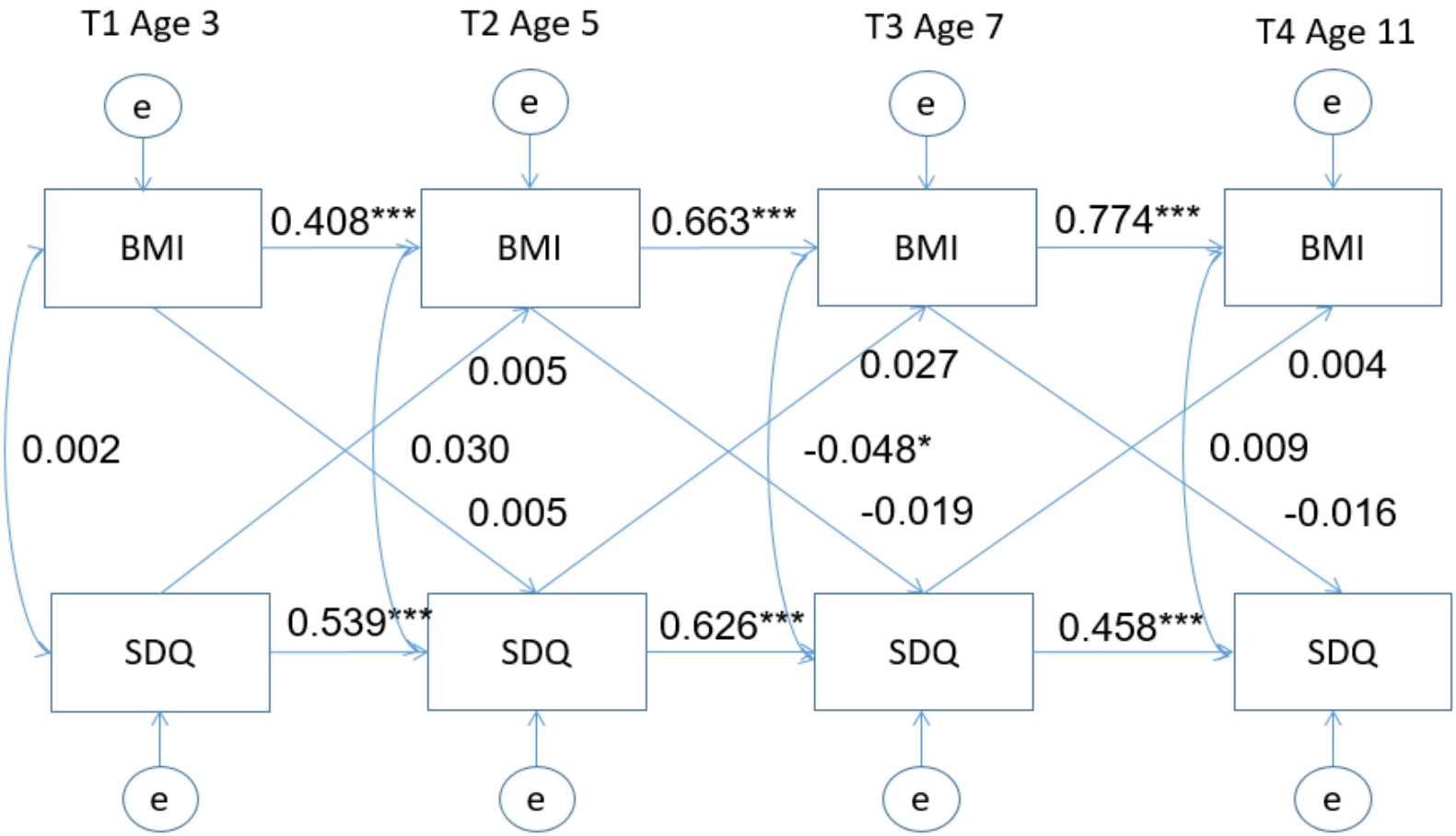

Figure A8. 4 Boys longitudinal cross-lagged effects model of BMI and externalising SDQ score fully adjusted for covariates and psychosocial stressors (n=3,254)

Chapter 11: Bibliography

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