



# GROWING UP IN SCOTLAND: Overweight, obesity and activity

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# **GROWING UP IN SCOTLAND:** Overweight, obesity and activity

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Responsibility for the opinions expressed in this report, and for all interpretation of the data, lies solely with the authors.

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## EXECUTIVE SUMMARY

Childhood obesity and low physical activity both have serious implications for children's health. This report had twin objectives: to explore determinants of both obesity and low physical activity in young children. Included in the investigation of obesity is an assessment of whether it is linked to low physical activity. The report also examined the extent to which mothers were aware of their child being overweight or obese and whether they were concerned by this.

### Research questions

- What potentially modifiable factors are associated with children's overweight and obesity?
- What potentially modifiable factors are associated with children's low activity levels?
- Do mothers recognise overweight in their child, and what factors are linked to better recognition?

### Possible influences on children's overweight or obesity and activity levels

Two main sets of possible influence on children's overweight/obesity and activity levels were considered: (1) **parental factors**, and (2) **family and neighbourhood factors** that might limit a family's ability to pursue a healthy lifestyle.

**Parental factors** considered included mother's overweight and her modelling of active and sedentary behaviour; child health-related practices likely to be under the parent's control such as children's snacking on unhealthy foods or playing outdoors; and general patterns of parenting.

**Family and neighbourhood factors** considered included socio-economic characteristics and maternal health as well as factors that might have closer link with a healthy lifestyle, such as a mother's attitudes towards a healthy lifestyle; or the provision of green spaces.

### The Growing Up in Scotland (GUS) study

The report uses data from almost 3,000 children in the Growing Up in Scotland study, a large nationally representative cohort study. Families have been surveyed every year for six years, from sweep 1 when children were 10 months old to sweep 6, conducted during 2010/11 when children were aged almost 6 years old (around 5 years 10 months).

### Measuring overweight, obesity and activity

Overweight or obesity was classified using BMI cut-offs derived from national population growth charts. At age 6:

- 22% of children were overweight (including obese)
- 9% of children were obese



Most of the overweight or obese children had been similarly classified two years previously, at age 4. Despite this “tracking” of overweight and obesity, there was considerable movement of children out of the overweight and obese groups over the two-year period. Half of children who had been obese at age 4 were no longer obese at age 6, although most were still overweight.

Physical activity and sedentary behaviour were measured using mothers’ reports of their child’s behaviour. Physical activity covered walking, organised sport and exercise and active play, at home and at school. Screen time (watching TV, and using computers or games consoles at home) was used as an indicator of sedentary behaviour. At age 6:

- 15% of children exercised for less than the recommended level of 60 minutes daily
- 31% of children had 3 or more hours screen time on a typical weekday

Children’s physical activity and sedentary behaviour at earlier ages were related to physical activity and sedentary behaviour respectively at age 6, suggesting that such behaviour may become habitual at an early age.

### **Factors associated with children’s overweight and/or obesity**

Statistical models of physical activity and sedentary behaviour allowed for a number of influences to be controlled for simultaneously. Models also allowed for a standard set of controls. These were the child’s gender, ethnicity, birthweight and family size. In respect of these standard controls for child characteristics and family size, all models found a significant effect of:

- higher birthweight on an increased likelihood of overweight or obesity
- being in a family with four or more children on a reduced likelihood of being overweight or obese.

The following parental factors were associated with a greater likelihood of the child being overweight and/or obese:

- mother’s overweight or obesity (mothers who were overweight or obese were more than twice as likely as mothers of healthy weight to have obese children)
- frequent snacking on sweets or crisps at toddler age
- skipping breakfast
- not eating the main meal in a dining area of the home
- low parental supervision

The strong association between mothers’ overweight or obesity and children’s BMI classification has been well established elsewhere. It may reflect several influences including an inherited predisposition to put on weight, continuation of the same environmental influences that led to a mother being overweight, and shared mother-child health practices related to diet and exercise.

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Snacking on crisps and sweets more than once a week was very common for GUS children when they were toddlers. The measure was useful as an indicator of children at *lower* risk (those who had snacks and crisps once a week or less frequently), rather than predicting higher risk of overweight and/or obesity. Skipping breakfast may reflect a more general association with poor dietary habits. Not eating the main meal in a dining area (either the kitchen, dining room or a combined living/diningroom) could indicate eating more unhealthy foods, perhaps under less parental control. Low parental supervision could reflect lower monitoring of a child's health-related behaviours and less protective behaviour to shield a child from possible health risks.

Many health-related practices suggested elsewhere as important for childhood overweight and obesity were not apparent in this study. These include shorter duration or absence of breastfeeding, early introduction of solids, soft drink consumption, fruit and vegetable consumption and use of convenience or fast food for the child's main meal. Low physical activity, high sedentary behaviour or short sleep duration did not predict increased risk of overweight or obesity.

Additional family and neighbourhood risk factors for healthy weight management were:

- poor maternal physical health
- low "child-friendliness" of the neighbourhood, based on mothers' assessments of the overall social and physical environment

The effect of poor maternal physical health requires further investigation, and could be linked to longstanding overweight in mothers. It seems unlikely that low child-friendliness is simply acting through constraints on physical activity, since children's activity levels as measured in GUS did not have clear associations with obesity. Further research is needed using objective measures of neighbourhood quality to see how they relate to mothers' perceptions.

## **Factors associated with children's low activity levels**

Statistical models of physical activity and sedentary behaviour allowed for a number of influences to be controlled for simultaneously. These models also allowed for a standard set of controls. These were the season of the year and various child characteristics: gender, ethnicity and family size.

Risk factors for low physical activity were:

- a less physically active mother
- a less warm mother-child relationship
- mother thought children require less than 60 mins/day physical activity
- no nearby swimming pool

Risk factors for high screen time were:

- mother's high screen time
- TV in the child's bedroom
- fewer mother and child shared activities
- fewer parental rules to guide behaviour
- greater social deprivation
- poor quality local green spaces

More work is required to see whether objective measures of green space quality align with mothers' views, but it seems plausible that without attractive local green spaces, families may spend more time indoors using screen entertainment.

### **Mothers' recognition and concerns for a child's overweight**

Most mothers with an overweight or obese child described their child's weight as "normal", with only 14% recognising their child as overweight. Mothers' recognition of overweight was improved if:

- their child was obese rather than overweight
- their child was a girl
- mothers were overweight or obese themselves

Mother's recognition of overweight was associated with greater concern for the child's weight. However, greater maternal recognition and concern at age 4 were not associated with child weight loss by age 6.

### **Strengths and limitations of the study**

This study was able to examine a wide range of potential risk factors for overweight and/or obesity and low activity in a large sample of Scottish 6 year olds.

Most, but not all, potential risk factors were measured in previous sweeps. However, it is important to note that the associations found do not necessarily show causal relationships. Associations may be due to other confounding factors that have not been studied, including influences that pre-date the birth of the child and inherited effects.

Although children's and mothers' BMIs were based on researchers' measurements of weight and height, most measures, including those for activity, rely on mothers' reports. The study did not include some relevant information, including detailed dietary information for children and parents, mother's BMI measured at earlier time points, and partner's BMI.

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## Comparison with other studies

The study extends previous research on children's obesity using other cohort studies (such as the Millennium Cohort Study) by incorporating a wider range of children's health behaviours related to diet and exercise, as well as more information on parenting. While this study found no evidence for some risk factors identified elsewhere (such as maternal smoking, breastfeeding, short sleep duration and television viewing), several findings, such as the influence of maternal BMI and dietary practices, are consistent with previous work. The Growing Up in Scotland data also suggest that low parental supervision may contribute to children's obesity, although other general aspects of parenting did not show a clear association with overweight and obesity.

In terms of risk factors for low activity levels, the study found no evidence for some risk factors identified in other work, such as maternal overweight, but it echoed other research indicating the role of parental modelling of active or sedentary behaviour, bedroom TV (for high screen time) and aspects of general day-to-day patterns of parenting.

## Policy implications

Many risk factors identified for young children's overweight and low activity are potentially modifiable, or would at least allow risk groups to be identified. The "tracking" of child overweight and activity from earlier ages suggests that early intervention may be most valuable.

The strong association between mother and child overweight, together with the importance of other parental factors, suggest that interventions to reduce child overweight and obesity may be most successful if they treat the family as a unit, rather than focusing exclusively on the child's weight. Improving mothers' recognition and concern for a child's overweight is likely to be only a first step in tackling the problem, since greater awareness may not translate into better weight management without addressing other aspects of parental behaviour. In terms of parenting, improving dietary practices and overall parental supervision appear to offer a promising approach.

For physical activity, there are also signs that interventions should be at the family rather than child level, to encourage parents and children to share a similar active lifestyle with a close parent-child relationship and structured behaviour management. Increasing mothers' awareness of desirable levels of physical activity for their children may also have a positive effect on parental encouragement and support for their child.

Better access to places where children can be physically active, including attractive green spaces, may increase activity levels and reduce sedentary behaviour. Further investigation is required to understand how the "child-friendly" aspects of the neighbourhood are associated with a lower level of child obesity.

# INTRODUCTION

## 1.1 Background

Childhood obesity and low physical activity both have serious implications for children's health. This report has twin objectives, exploring potentially modifiable determinants of both obesity and low physical activity in young children. Included in the investigation of obesity is an assessment of whether it may be linked to low physical activity. The report also contains a section focusing on children defined as overweight or obese, examining the extent to which mothers were aware of this overweight and were concerned by it.

### 1.1.1 *Childhood overweight and obesity*

Childhood obesity is associated with an increase in childhood cardiovascular risk factors. Childhood obesity may persist into adult life, and adults who were obese as children have a higher risk of diseases associated with obesity, including type 2 diabetes, hypertension, cardiovascular disease, osteoarthritis and cancer (Hannon et al. 2005; Burke 2006; Nathan and Moran 2008).

The United Kingdom has one of the highest levels of childhood obesity among developed countries<sup>1</sup>. In Scotland, the prevalence of obesity among 2-15 year-old children was 14% in 2010, and three in ten children (29.9%) were overweight or obese (Gray and Leyland 2011). Future projections have suggested increasing levels of childhood obesity in the UK, accompanied by considerable social, economic and health costs (Butland et al. 2007; Stamatakis et al. 2010b). In recent years there appears to have been little change in the prevalence of overweight or obesity among Scottish children. While childhood obesity rates may also be stabilising in England, there are indications of widening socio-economic disparities as obesity continues to rise among children from lower socio-economic groups (Stamatakis et al. 2010a).<sup>2</sup>

Tackling obesity is an important policy objective for the Scottish Government. The Scottish Government has established a National Performance Framework indicator on child healthy weight<sup>3</sup> and NHS prevention and treatment services for overweight or obese children across Scotland. 40% of interventions during 2011-2014 are targeted to children living in the two most deprived SIMD quintiles.<sup>4</sup> The Scottish Government's commitment to tackling the causes of childhood obesity is underlined by a number of additional policy initiatives:

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1 See [http://www.oecd-ilibrary.org/sites/health\\_glance-2011-en/02/04/index.html?contentType=&itemId=/content/chapter/health\\_glance-2011-19-en&containerItemid=/content/serial/19991312&accessItemids=/content/book/health\\_glance-2011-en&mimeType=text/html](http://www.oecd-ilibrary.org/sites/health_glance-2011-en/02/04/index.html?contentType=&itemId=/content/chapter/health_glance-2011-19-en&containerItemid=/content/serial/19991312&accessItemids=/content/book/health_glance-2011-en&mimeType=text/html)

2 No information on this is currently available for Scotland.

3 See <http://www.scotland.gov.uk/Publications/2007/11/13092240/0>.

4 For further details see <http://www.scotland.gov.uk/About/scotPerforms/partnerstories/NHSScotlandperformance/childhealthyweight>

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- Healthy eating, active living action plan 2008-2011 (Scottish Government 2008)
- Good Places, Better Health for Scotland's Children (Evaluation group of Good Places Better Health 2011) including a childhood obesity evidence assessment published December 2011<sup>5</sup>
- Obesity route map (2010) and action plan (2011) (Scottish Government 2010; Scottish Government 2011)<sup>6</sup>

## 1.1.2 Children's physical activity

Physical activity in children is important to promote bone strength and normal skeletal development, and greater activity has been linked with reduced adiposity and cardiometabolic risk factors in childhood (Riddoch et al. 2009; Janz et al. 2010; Owen et al. 2010). Children who are more physically active may continue being active into adulthood, when there are well established health benefits (Telford 2007). Establishing a physically active lifestyle in childhood may help counter the trend for adolescents (especially girls) to reduce their levels of physical activity (Van Der Horst et al. 2007).

In 2011 the UK Government published guidelines on recommended levels of physical activity in children and young people aged 5-18 years (Department of Health 2011). These were threefold:

- Children and young people should engage in moderate to vigorous activity for at least 60 minutes and up to several hours every day
- Vigorous activities, including those that strengthen muscles and bones, should be carried out on at least 3 days a week
- Extended periods of sedentary activities should be limited

The Scottish Health Survey in 2010 found that around 35% of children aged 2-15 years did not appear to be meeting the target threshold of at least 60 minutes of physical activity daily. Over the 2008-10 period, around a quarter of 5-7 year olds did not meet this threshold (Marryat 2011).

Incorporating physical activity as part of a healthy lifestyle forms a core part of policy measures designed to tackle childhood obesity. The Scottish Government has incorporated the UK guidelines as part of its National Physical Activity Strategy<sup>7</sup>. The need for children to enjoy regular physical activity is recognised by the Scottish Curriculum for Excellence<sup>8</sup>, and the Active Schools programme promotes opportunities for physical activity outwith PE lessons<sup>9</sup>.

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5 For the obesity evidence, see <http://www.scotland.gov.uk/Topics/Health/good-places-better-health/Recommendations/Obesity>

6 See <http://www.scotland.gov.uk/Resource/Doc/302783/0094795.pdf> and <http://www.scotland.gov.uk/Resource/Doc/346007/0115166.pdf>

7 See <http://www.scotland.gov.uk/Topics/Health/health/Introduction>

8 See <http://www.ltscotland.org.uk/understandingthecurriculum/whatiscurriculumforexcellence/index.asp>

9 See <http://www.sportscotland.org.uk/ChannelNavigation/Topics/TopicNavigation/Active+Schools/>

## 1.2 Research into risk factors for childhood obesity: multiple causes

The rapid increase in childhood obesity in recent decades appears to result from a biological predisposition to put on weight, coupled with an increasingly obesogenic environment due to wider availability of low cost, high energy foods and reduced physical activity (Butland et al. 2007). Multiple environmental influences on weight gain have been implicated, and variants of an “ecological model” of obesity (Davison and Birch 2001) have been used to categorise predictors of childhood obesity from several different “levels of influence”: the child’s own characteristics, plus those of the family and wider community.

This ecological model has been used in several recent analyses of childhood overweight and obesity based on data from the UK Millennium Cohort Study (MCS) (Brophy et al. 2009; Hawkins et al. 2009c; Hawkins et al. 2009d; Griffiths et al. 2010; Connelly 2011; Jones et al. 2011b). Studies differed according to the age of child studied (3, 5 or 7 years) and the measures selected for study, so it is not unexpected to see some variation in findings. Consistent risk factors identified at ages 3, 5 and 7 were greater child birthweight, child ethnicity, and parental overweight (Brophy et al. 2009; Hawkins et al. 2009b; Connelly 2011). Of particular relevance to this report is the MCS study on 5 year olds (Brophy et al. 2009), which identified some additional risk factors related to maternal characteristics (poor health, smoking and low educational attainment) and to children’s eating habits and a sedentary lifestyle.

The use of an ecological model for childhood obesity is complicated by the strong inherited component to childhood weight (Haworth et al. 2008; Silventoinen et al. 2010). Associations between child or family characteristics and obesity may thus reflect genetic as well as environmental influences. A second complication relates to a difficulty in establishing the nature and timing of any environmental influences, especially when using data gathered over a restricted time period. It is important to bear in mind that associations found between the child’s environment and obesity do not necessarily show a causal relationship, but might reflect other influences operating at an earlier date. Several studies have pointed to early risk factors for children’s obesity that predate the birth of the child. These include mother’s pre-pregnancy BMI (Hawkins and Law 2006), mother’s smoking during pregnancy (Oken et al. 2008) and intra-uterine effects on appetite, metabolism, and activity levels (Smith et al. 2007; Oken 2009). These complications mean that while ecological “levels of influence” form a useful conceptual model, they leave many unanswered questions about mechanisms for any risk factors identified.

## 1.3 Parental influences on childhood obesity and constraints on healthy weight management

Parents are likely to have a dominant influence on the lives of young children. They may also act as “filters” for many other family- and community-level influences. This means that although some family and community-level factors may have a direct effect on the child, the influence of many other such factors may depend on how parents respond to pressures such as low income or a poor neighbourhood environment.

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This report uses a simplified ecological model, focusing on two main categories of influence on childhood obesity:

- Parental influences
- Family-level and neighbourhood-level constraints on healthy weight management

The report also contains a section focusing on children defined as overweight or obese, investigating the extent to which their mothers are aware of this overweight and are concerned by it.

## **1.3.1 Parental influences**

Several aspects of parenting are relevant when considering possible influences on childhood obesity. Children's health-related practices including nutrition, exercise and sleep are under the control of the parent. While nutrition and exercise have an obvious link to a child's energy balance, sleep has also been linked with children's obesity. A review of several studies found an association between short sleep duration and children's obesity (Chen et al. 2008). This review included a British prospective cohort study, which found that short sleep duration at 30 months was associated with increased obesity risk at 7 years (Reilly et al. 2005). The mechanism for the association is however unclear, although it may relate to appetite regulation.

Parental example is also likely to be important. Here we include modelling healthy behaviours, together with the well established association between parental and child overweight (Wu and Suzuki 2006). There are, however, a number of possible reasons for the association between parental and child overweight: these include a genetic component, epigenetic effects, continuation of the same neighbourhood influences that originally contributed to parental overweight, sharing of attitudes and practices relevant for the child's nutrition and physical activity, and modelling body image.

A third, less explored, parental influence relates to more general patterns of parenting. A recent review (Kitzmann et al. 2008) sought to explain why attempts to improve health-related parenting practices have often failed to reduce children's weight or improve their diet and exercise. It suggested that day-to-day parenting is critical for the successful institution of health-related parenting practices. Parents who are permissive or "indulgent" (lacking rules, routines and enforcement of behavioural boundaries) will not provide adequate support for children learning how to self-regulate their behaviour. Families with low support and cohesion or with high levels of conflict may find it more difficult to institute health-related parenting practices such as family meals or joint family outings to parks and playgrounds. These ideas have found support in observational studies (Sleddens et al. 2011).

## **1.3.2 Family and neighbourhood constraints on healthy weight management**

At the level of both the family and the wider community, there may be factors that act as a set of "constraints" or limitations on the ability of children to follow a healthy lifestyle. Many of these constraints may impact on the parental influences identified in the previous section.



Some family- and community-level factors may affect parental institution of health-related practices for their children. For example, low income or living in a poor neighbourhood could limit access to resources such as shops providing nutritious food, or gardens and parks for physical exercise (Dunton et al. 2009). Parents with longer working hours might have less time and energy to spend on preparation of healthy meals or exercise with their children (Hawkins et al. 2009a). Other constraints might operate through their impact on parental example. A recent UK study found that conditions in deprived neighbourhoods showed few direct associations with their 3-year-old's weight, but were associated with a mother's overweight (Hawkins et al. 2009e). Lastly, some constraints might impact on more general patterns of parenting. For example, a lack of time or poor parental health may create family stresses that impair effective parenting (Topham et al. 2010).

### **1.3.3 Parental recognition of overweight, and concerns about their child's weight**

Parents who do not recognise that their child is overweight, or who express no concern about their child's overweight, are unlikely to be motivated to try to manage the child's behaviour so that the child eats a healthy diet and takes physical exercise. Other work has found that mothers generally find it difficult to recognise that a child is overweight (Parry et al. 2008; Jones et al. 2011a). Mothers' recognition of overweight appears to be more difficult when children are young (Crawford et al. 2006; Eckstein et al. 2006).

The ability of parents to recognise overweight is best studied in relation to children who are defined as overweight, using objective measures such as BMI. More generally, low levels of parental concern about a child's weight might be viewed as one of the "family constraints" on management of healthy child weight. Here, the assumption is that parents who are not concerned about their child's weight may be less likely to ensure their child adopts healthy dietary and physical activity behaviours.

## **1.4 Research into factors associated with children's physical activity**

Like research on risk factors for childhood obesity, research on children's physical activity has typically categorised possible determinants of physical activity into a number of different groups (Sallis et al. 2000a; Van Der Horst et al. 2007; Hinkley et al. 2008). These may include consideration of the child's growth and physical fitness, together with psychological factors such as the child's motivation and attitudes to physical activity, although the group of psychological factors is difficult to study in young children. Three other groups of influence commonly studied are:

- Behavioural attributes and skills. Children's physical activity may depend on the early development of active behaviour patterns and formation of important skills
- Physical environment (for example, access to facilities such as play parks)
- Social and cultural influences. This includes factors such as parental modelling and encouragement of physical activity, attitudes of the child's peers, and school-level policies favouring active behaviour

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Reviews of the determinants of physical activity in children (Sallis et al. 2000a; Van Der Horst et al. 2007; Hinkley et al. 2008) have noted many inconsistent findings between studies. In part, these may relate to differences in the populations studied. In addition, different aspects of physical activity (such as children's school-based activity or out of school activity, or organised activity versus informal active play) may have different determinants. Determinants of physical activity found studies of children aged 4-12 years were male gender, self-efficacy (the child feeling that he/she is capable of active behaviour), parental physical activity and parent support (Van Der Horst et al. 2007). In pre-school children, male gender and parental physical activity were also shown to be important, together with spending time outdoors (Hinkley et al. 2008).

Less is known about the determinants of children's sedentary behaviour. It may have different determinants from physical activity, and may not substitute for physical activity in a simple fashion. However, a recent large UK cross-sectional study using objective measurements of 7-year-olds' physical activity suggested that there were some common factors underlying both higher physical activity and reduced sedentary behaviour, including the child's lower weight status and parental modelling behaviour (King et al. 2011).

## 1.5 Using the Growing Up in Scotland (GUS) study to investigate children's overweight/obesity and activity

The Growing Up in Scotland study (GUS) is well placed to investigate the role of parents on children's overweight or obesity and their physical activity. GUS has measures of both health-related parenting practices (e.g. taking child to the park or playground) and general patterns of parenting (rules, routines, supervision, involvement with the child, warmth and conflict). GUS can also be used to examine effects of parental overweight and modelling of active and sedentary behaviours. There is a wide range of potential family and neighbourhood constraints on healthy child weight management, ranging from parental attitudes and knowledge to social and physical aspects of the child's neighbourhood.

## 1.6 Research questions

Two main research areas were examined in this study: identification of potentially modifiable factors associated with children's overweight and obesity, and factors associated with low activity levels in children. These areas are followed by a third topic exploring mothers' recognition of children's overweight.

### 1.6.1 *What potentially modifiable factors are associated with children's overweight and obesity?*

Potentially modifiable factors were categorised as parental factors or influences, and family or neighbourhood constraints on healthy weight management.

- **Parental factors.** Three areas were distinguished:
  1. **Health-related practices** related to the child's diet and activity levels. For example, what is the impact of snacking on unhealthy foods, or having a TV in the child's bedroom?

2. **Parental example.** What is the influence of mother's overweight, and of mother's physical activity and sedentary behaviour?
  3. **General patterns of parenting.** What is the role of a strong mother-child relationship and effective behaviour management in preventing children's overweight or obesity?
- **Family constraints on healthy weight management.** Can children's overweight and obesity be attributed to a mother's low level of education or low family income? What is the role of a mother's concerns for her child's weight and her views on desirable levels of children's physical activity?
  - **Neighbourhood constraints on healthy weight management.** Can children's overweight or obesity be linked to living in an urbanised rather than a rural environment, or to living in a more deprived area? Can overweight and obesity be linked to access and quality of local facilities such as children's play areas, or to local crime and antisocial behaviour?

### ***1.6.2 What potentially modifiable factors are associated with children's low activity levels?***

The areas examined were identical to the previous section for overweight and obesity (removing health-related practices from the set of parental factors).

- **Parental factors.** Two areas were distinguished:
  1. **Parental example.** What is the influence of mother's overweight, or of mother's physical activity and sedentary behaviour?
  2. **General patterns of parenting.** What is the role of a strong mother-child relationship and effective behaviour management in supporting children to be more active?
- **Family constraints on active behaviour.** Does low family income or long parental working hours limit children's opportunities for active behaviour? What is the role of a mother's concerns for her child's weight and her views on desirable levels of children's physical activity?
- **Neighbourhood constraints on active behaviour.** Does living in an urbanised or a more deprived area limit children's scope for active behaviour, compared to more rural or more affluent areas? Do accessible, high quality children's play, exercise and sports facilities promote physical activity? Do safety concerns and high antisocial behaviour reduce opportunities for activity?

### ***1.6.3 Mother's recognition of overweight in their child***

This part of the investigation focused on the subset of children who were overweight (including obese). It explored levels of maternal recognition of overweight and concerns for overweight, and what factors were associated with greater or lower recognition. It then looked at whether a mother's ability to recognise overweight in their child at age 4 may have led to the child losing weight by age 6.

## 2.1 Sample

The data used were taken from the sixth sweep/year of GUS which was conducted over a 14-month period starting in April 2010, when survey children were approaching their sixth birthdays (average age 5 years 10 months). In all, interviews were conducted with 3657 families (representing 70% of the 5217 families interviewed in the first sweep of data collection). At sweep 1, the survey was designed to be representative of the Scottish population. To compensate for biases introduced through survey attrition, longitudinal survey weights were used in all analyses (see 2.6).

Among the sweep 6 families, we excluded children from multiple births ( $n=67$ ) and cases where the survey respondent was not the child's natural mother (a further 89 cases), leaving 3501 cases (96% of families contacted at this sweep). To avoid inconsistencies arising from differences in the identity of the main carer interviewed at earlier sweeps, we then further restricted the eligible sample to cases where the natural mother had provided information at all previous sweeps ( $n=3160$ ). This restricted sample was similar to the full sweep 6 sample, while containing slightly lower proportions of children from ethnic minority groups (2.9% compared to 3.6% in the full sample), mothers without formal educational qualifications (8% compared to 9.4% in the full sample), families with absent fathers (22.2% compared to 23.4%) and families living in the most deprived areas (20.5% living in the most deprived SIMD quintile, compared to 21.9% in the full sample).

At each sweep/year of fieldwork, interviews took place around six weeks before the child's next birthday, therefore in the first year of the study, children were 10 months old, in the second year they were 22 months old and so on. For the purposes of this report, beyond the first interview, the child's age will be referred to in years. It is worth bearing in mind however, that a 4-year-old child at sweep 4 for example, is actually 46 months old or just under 4, and a 6-year-old child at sweep 6 is actually 70 months old or just under 6.

## 2.2 Defining overweight and obesity

Body Mass Index (BMI) scores were calculated using children's height and weight measured by trained researchers at the sweep 4 and 6 interviews. Classification of overweight and obesity in children using BMI is complicated by variation in patterns of growth, weight gain and changes in body composition. To define overweight and obesity, UK thresholds appropriate for the child's gender and age using the National BMI percentiles classification (based on UK 1990 reference growth curves) were applied to children's BMI scores, following a method developed by ISD Scotland also used for the Scottish Health Survey (Gray and Leyland 2011). Most children (those below the 85th percentile) are classified as of healthy weight, with a small number at or below the 5th percentile who are underweight. Children at or above the 85th percentile but below the 95th percentile are considered to be overweight. Children at or above the 95th percentile are classed as obese, including those at or above the 98th percentile who are classed as morbidly obese.

This study examined two main groups of children: those considered either overweight or obese (all those at or above the 85th percentile), and those considered obese (all those at or above the 95th percentile).

## 2.3 Defining physical activity and sedentary behaviour

Two measures were created to show whether children were meeting two of the recommended UK guidelines (Department of Health 2011) for physical activity. Intensity of children's physical activity is difficult to measure with survey questions. There was no measure of vigorous activity on at least three days a week, so – like the Scottish Health Survey – this report focuses on the first and third guidelines.

The two measures were:

### 1. Physical activity for 60 minutes or more, seven days a week

At sweep 6, mothers were asked about their child's participation in four types of physical activity (for at least 5 minutes) in the past week. For activities outside school, these included walking, organised sports or exercise activities such as swimming lessons or a gymnastics class, and other active behaviour such as running about, riding a bicycle or kicking a ball around. Mothers were also asked whether their child had taken part in walking, sports, exercise or other active things when the child was at school.

For each of these different types of physical activity, mothers were asked for the number of weekdays and the number of weekend days on which their child had engaged in the activity, and for the duration of each type of activity on both a weekday and a weekend day in the past week. Average duration was recorded using a 10-point scale, running from (1) at least 5 minutes but under 15 minutes to (10) 4 hours or more. Following procedures developed for the Scottish Health Survey, this information was used to estimate typical total physical activity time per week and to classify children into three groups:

- those active for 60 minutes or more on all seven days
- those active for between 30 and 59 minutes on all seven days
- those with lower levels of activity

This report compared the first group (those meeting the guideline for recommended physical activity) with the second and third groups of children who had lower than recommended activity levels.

### 2. Sedentary behaviour

Screen time was used as a measure of sedentary behaviour. Mothers were asked how long their children spent watching television (including DVDs and videos), and how long they spent using a computer or games console, on a typical weekday and a typical Saturday. Duration was recorded in hours, or fractions of hours.

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This report compared children who used screens for under 3 hours on a typical term time weekday with those who used screens for 3 hours or more. (See section 4.7 for more information on why this cut off was chosen).

## 2.4 Conceptual framework to explore factors associated with children's overweight and obesity at age 6

We explored associations between possible risk factors and children's overweight and obesity at age 6. There were two main sets of risk factors: parental factors, and family and neighbourhood constraints. Detailed information on derived measures used is provided in the Appendix, section 8.1.

### 2.4.1 Parental factors

There were three main types of parenting factors (Table 2.1 shows the sweep(s) at which information was available):

- Parental example. Mother's overweight or obesity measured at age 6, and mother's physical activity and screen time were measured at age 5. Note that there are no measures of maternal diet in the GUS survey.
- Health-related practices regarding children's nutrition, physical activity and sleep. Here, measures of children's behaviour such as eating sweets or watching TV have been included under "parenting", on the assumption that these behaviours are to a large extent modifiable by parents.
- General patterns of parenting. This covered "connection" (loving and caring for the child), control (management of the child's behaviour) and conflict. These measures were previously used in a Growing Up in Scotland report on Parenting and Children's Health (Parkes and Wight 2011). Connection was measured using questions about the warmth of the parent-child relationship, and the number of joint parent-child activities (such as reading and playing). Control was measured using questions about rules for the child's behaviour, parental supervision of the child and "household chaos" or disorganisation. Conflict was measured using questions about the degree to which parent and child struggle with one another, or how easily the child becomes angry with the parent.

**Table 2.1 Parental factors examined in relation to children's overweight and obesity at age 6**

Building blocks of model	Measures	Age measured/ Sweep(s) providing information	
<b>1) Parental example</b>	Mother's overweight/obesity	6	
	Mother's physical activity	5	
	Mother's screen time	5	
<b>2) Health-related practices</b> <b>i) Nutrition</b>	Infant feeding (duration of breastfeeding, timing of introduction of solids)	1	
	Pattern of eating (snacks and/or meals, whether has regular mealtimes, whether skips breakfast), room where child eats main meal	2,5	
	Snacks (what child mainly snacks on: crisps, fruit, etc), frequency of sweets, crisps and soft drinks, mother's perceived ease of regulating sweet consumption)	2,5	
	Fruit and vegetable consumption (variety)	2,5	
	Consumption of fast food and convenience food	3,5,6	
	<b>ii) Physical activity and sedentary behaviour</b>	Use of local facilities (swimming pool, play park)	2
		Active behaviours (walking, playing outdoors, etc)	2,5,6
TV in bedroom		4,5	
Time watching TV/playing electronic games		3,4,5,6	
<b>iii) Sleep</b>	Duration of sleep	1,3,6	
	Sleeping patterns	1,3,6	
	Sleeping problems	1,2,3,4,5,6	
<b>3) General patterns of parenting</b>	Warmth of relationship with child	5	
	Joint activities with child	2,3,4	
	Supervision	4	
	Rules	2,5	
	Home chaos	5	
	Conflict in relationship with child	5	

### **2.4.2 Family and neighbourhood constraints on healthy weight management**

Family and neighbourhood constraints are factors that might limit a family's ability to follow a healthy diet and engage in recommended levels of physical activity. Information on the measures available in GUS is shown in Table 2.2.

Family constraints may be related to lack of time, low income, cultural norms, low awareness of healthy weight and healthy eating and exercise practices, and stress on family functioning due to poor maternal physical and mental health. Mother's smoking during pregnancy has been included as a potential health-related constraint. There is evidence that maternal smoking during pregnancy is associated with child overweight even after allowing for sociodemographic and behavioural differences between smokers and non-smokers (Oken et al. 2008), although the mechanisms for this effect are not clear.

Neighbourhood constraints might reflect availability, access, quality and safety in relation to various aspects of the physical and social neighbourhood environment.

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Within each of the two sets of family and neighbourhood constraints, we can distinguish factors that are distal or more proximal. Proximal factors might explain how more distal factors affect obesity. For example, within the set of family factors a mother's long working hours is here considered as a distal factor, possibly influencing obesity through the more proximal factor of time constraints on food preparation (perhaps leading to greater use of convenience foods?). Within the set of neighbourhood factors a more deprived neighbourhood (distal factor) might influence obesity via more proximal factors, such as low neighbourhood safety and poorer quality play areas for children.

**Table 2.2 Information on family and neighbourhood constraints associated with children's overweight and obesity at age 6**

Building blocks of model	Measures	Age measured/ Sweep(s) providing information
<b>1) Family</b>		
<b>Distal</b>		
Mother's time at home	Mother's employment (hours)	5
Income, culture and knowledge- related	Mother's age at birth of first child	1
	Mother's education	1
	Biological father in household	1 to 6
	Household income	1 to 6
	Mother's social class	1
Health-related	Mother's mental health	1,3,5
	Mother's physical health	1,3,5
	Mother's smoking during pregnancy	1
<b>Proximal</b>		
Time	Mealtime quality (a rush, time to talk, enjoyable)	2,5
	Mother's food preparation affected by time	2,5
Income, culture and knowledge- related	Mother's food preparation affected by cost, knowledge of healthy eating	2,5
	Mother's recognition and concern for child's weight	4,6
	Mother's views on desirable levels of children's physical activity	6
<b>2) Neighbourhood</b>		
<b>Distal</b>	Area deprivation	1 to 6
	Urban-rural classification	1 to 6
<b>Proximal</b>		
Access to places to play/ exercise/eat	Access to garden	1
	Access to play park	1
	Proximity to green space	6
	Swimming pool in area	2
	Take away in area	6
Quality of places to play/ exercise	Rating of green spaces and play areas	6
Safety/trust in local area	Safety by day and night, antisocial behaviour problems, safe play areas, "child friendly" neighbourhood	3,6



## 2.5 Conceptual framework to explore factors associated with children's physical activity and sedentary behaviour at age 6

Exploration of factors associated with children's physical activity and sedentary behaviour followed a similar pattern to the outline given in the previous section. Under parental factors, parental example, health-related practices related to children's physical activity and general patterns of parenting were included. Health-related nutritional practices were excluded. Under family and neighbourhood constraints, there was the same list of distal factors. Proximal family and neighbourhood constraints included those related to exercise (e.g. mothers' views on desirable levels of children's physical activity and quality of local play areas). Other measures related exclusively to nutrition, such as mother-reported time or money constraints on food preparation, were omitted.

## 2.6 Analysis

All analysis allowed for the stratified and clustered survey design and weighted the data to compensate for attrition of the survey sample between sweeps 1 and 6. Tables display both weighted (Wtd) and unweighted (Uwtd) bases. Bivariate exploration was carried out using SPSS complex surveys syntax. Multivariate modelling was carried out using STATA after multiple imputation of missing data. Multivariate modelling controlled for child characteristics (gender, birthweight and white/minority ethnic group<sup>10</sup>) and family characteristics (number of siblings). Birth weight was standardised for gender, gestational age and parity using tables recently published for Scottish infants (Bonellie et al. 2008). Readers interested in the details of the analyses should consult the Technical Appendix published alongside this report.

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10 Small numbers precluded further division of the minority group category.

## OVERWEIGHT AND OBESITY

This section describes the prevalence of overweight and obesity amongst Scottish children at age 6. It examines whether age 4 overweight and obesity were associated with being overweight or obese two years later. It then goes on to explore factors associated with children's overweight or obesity at age 6.

### 3.1 Key findings

- 22% of children were overweight (including obese), 9% were obese.
- Risk factors for children's overweight and obesity include child characteristics (higher birthweight), maternal characteristics (high BMI and poor physical health), neighbourhood characteristics (low child friendliness), dietary practices and low parental supervision
- Children who were overweight and obesity at age 6 were very likely to have been classified as overweight or obese at age 4
- Physical activity and sedentary behaviour were not clearly associated with children's overweight and/or obesity

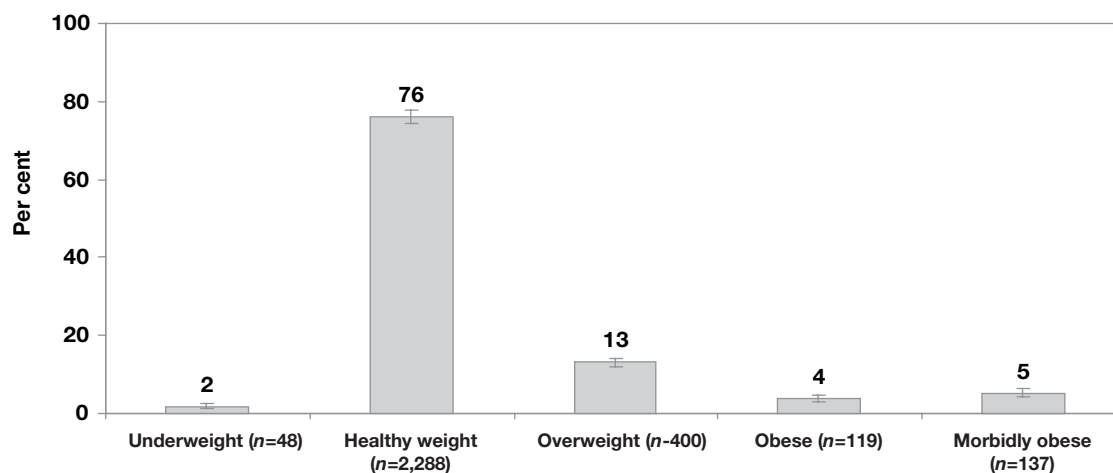
### 3.2 Prevalence and tracking of children's overweight and obesity

#### 3.2.1 Prevalence of overweight and obesity at age 6

Reliable height and weight measurements were obtained from 3035 children (96% of the eligible sample at sweep 6). Following standard procedures developed by ISD Scotland, children with BMI values more than three standard deviations from the mean population value were excluded ( $n=43$ , 1%), leaving 2992 cases.

Of these, three-quarters (76%) had BMI in the healthy range, 22% were overweight including obese, consisting of 13% who were overweight but not obese, and 9% who were obese or morbidly obese (Figure 3.1). It is not possible to make a precise comparison of these figures collected in 2010-11 for GUS children approaching their sixth birthday with the prevalence of children's overweight and obesity measured in the 2010 Scottish Health Survey, SHeS (Gray and Leyland 2011), as the SHeS does not provide a detailed breakdown by age. SHeS data found that 26% of children aged 2-6 years were overweight (including 11% obese), while 31% of children aged 7-11 years were overweight (including 18% obese).

Figure 3.1 Children’s BMI classification at sweep 6

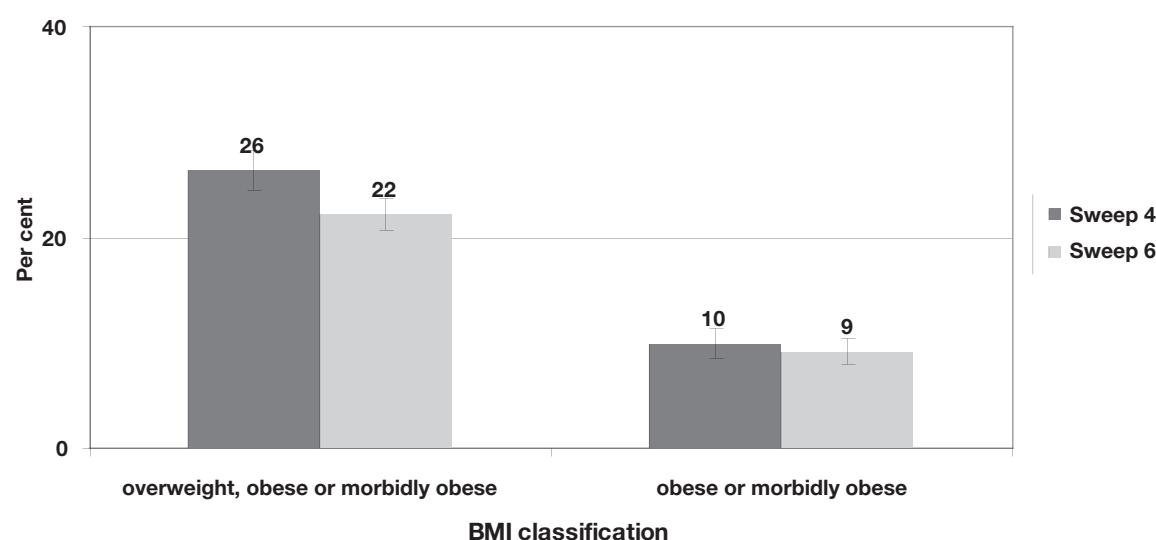


BMI classification at sweep 6

Note: Numbers above each histogram show estimated percentage in each BMI category, with error bars indicating 95% confidence intervals. *N* values for number of cases in each BMI category are unweighted values. *n*=2992

The prevalence of overweight (including obesity) at age 6 (22%) was slightly reduced from that at age 4 (26%). However, the prevalence of obesity was similar at both ages (see Figure 3.2).

Figure 3.2 Prevalence of children’s overweight and obesity at ages 4 and 6



Note: Numbers above each histogram show estimated percentage in each BMI category, with error bars indicating 95% confidence intervals.

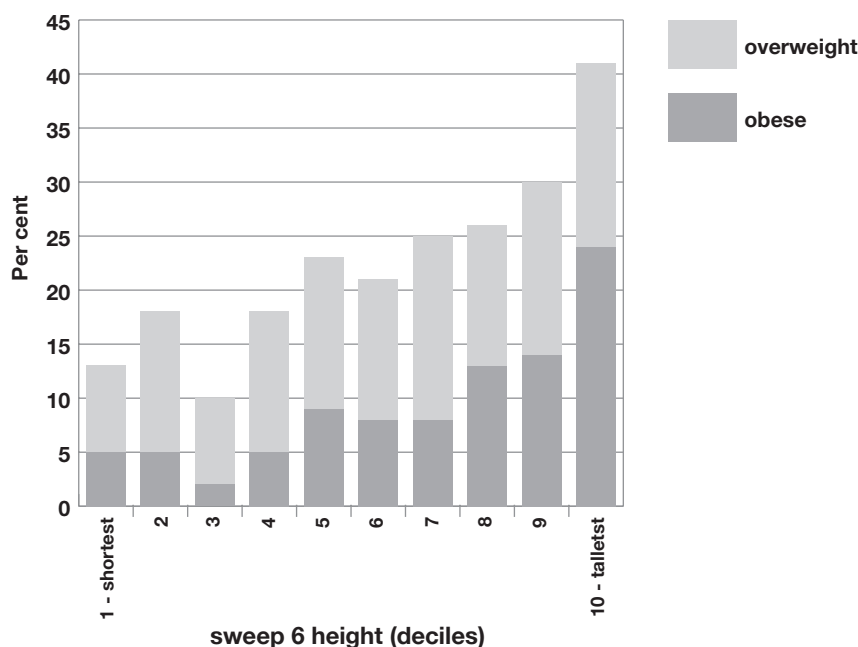
# GROWING UP IN SCOTLAND:

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## 3.2.2 Association between overweight/obesity and children's height

Figure 3.3 shows that there was a strong association between height and overweight or obesity, with taller children more likely to be classified as obese or overweight. Other research has recognised this association, and considered whether the BMI measure might be misclassifying taller children (Freedman et al. 2003). However, this work found that taller children had greater skinfold thickness and raised insulin levels, and that childhood BMI was more strongly linked with adult adiposity than alternative indices relating height and weight measurements. The researchers concluded that BMI was more useful than alternative ways of relating weight and height measurements, and that the association between children's height and BMI does indeed reflect greater adiposity in taller children.

**Figure 3.3 Association between children's height and overweight or obesity**



## 3.2.3 Tracking of overweight and/or obesity

This section examines associations between children's overweight/obesity at age 4 and obesity/overweight two years later, referred to as "tracking" of overweight and/or obesity.

The vast majority (90%) of children classified as healthy weight at age 4 remained in this category two years later (Table 3.1), with only 8% becoming overweight or obese. There was considerable tracking of overweight and/or obesity, in that children who were overweight or obese at age 4 were much more likely than healthy weight children to have weight problems two years later. However, there was considerable movement out of the overweight and obese categories over the two-year period.

Overall, 60% of children classified as either overweight, obese or morbidly obese at age 4 (combining three columns of Table 3.1) were also overweight or obese at age 6, but 40% became of healthy weight. Almost half (48%) of children classified as either obese or morbidly obese at age 4 (combining two columns of Table 3.1) were similarly classified at age 6, 37% were reclassified as overweight and 15% became a healthy weight.

**Table 3.1 Association between children's BMI at age 4 and age 6**

Age 6 BMI classification	Age 4 BMI classification						Bases	
	Under-weight	Healthy weight	Overweight	Obese	Morbidly obese	Wtd	Uwtd	
	%	%	%	%	%			
Underweight	25	2	-	-	-	47	47	
Healthy weight	75	90	54	21	8	2069	2136	
Overweight	-	6	31	45	25	351	369	
Obese	-	1	6	14	21	103	109	
Morbidly obese	-	1	9	20	47	137	120	
<b>Total</b>	100	100	100	100	100	2707	2781	

### 3.3 Exploration of child and family factors associated with children's overweight and obesity

**Important note: From this point forward, the term “overweight” is used to include all children at or above the 85th BMI percentile (i.e. including those who were obese or morbidly obese). The term “obese” includes all children at or above the 95th BMI percentile (i.e. including those who were morbidly obese).**

Associations between individual child and family characteristics and children's overweight and obesity were explored (Table 3.2). Note that these associations do not take account of other factors that simultaneously may play a role.

Greater birthweight (standardised for gender, gestation and parity) was strongly associated with being overweight or obese at age 6. Neither gender, ethnicity, birth order or number of siblings was clearly associated with being overweight or obese, although there was a trend for children from larger families to be at lower risk. The GUS sample contains only a small percentage of children from ethnic minority groups, so is not as well placed to explore ethnic differences in overweight and obesity as the Millennium Cohort Study, which has a boosted ethnic sample.

**Table 3.2 Child and family characteristics: associated with with children's overweight and obesity at age 6, bivariate analyses**

		% overweight or obese	<i>p</i>	% obese	<i>p</i>	Bases	
						Wtd	Uwtd
<b>Gender</b>	Male	23	NS	8	NS	1502	1521
	Female	22		10		1433	1471
<b>Ethnicity</b>	White	22	NS	9	NS	2814	2892
	Minority group	20		11		120	99
<b>Birthweight (standardised)</b>	1 - lowest decile	12	***	7	†	325	300
	2	14		6		311	298
	3	15		7		300	293
	4	23		12		294	303
	5	23		8		289	295
	6	23		9		292	301
	7	25		11		288	302
	8	26		9		283	299
	9	32		14		269	296
	10 - highest decile	32		11		279	298
<b>Birth order</b>	First born	23	NS	9	NS	1472	1445
	Not first born	21		9		1463	1547
<b>Number of children in household</b>	One	25	†	11	†	585	552
	Two	22		9		1538	1643
	Three	22		9		621	635
	Four or more	14		5		192	162

Notes: *p*=probability of difference between groups based on adjusted F where NS=not significant, † *p*<0.1, \**p*<0.05, \*\**p*<0.01, \*\*\**p*<0.001.

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## 3.4 Exploration of parental factors associated with children's overweight and obesity

There were a number of statistically significant associations ( $p < 0.05$ ) between individual parental factors and children's overweight and/or obesity, shown in Table 3.3. Note that these associations do not take account of other possible confounding influences. Significant associations with children's overweight and/or obesity included:

- Mother's overweight or obesity
- Nutritional practices related to
  - Infant nutrition including duration of breastfeeding and the timing of solids
  - Frequency of consumption of sweets and crisps as a toddler (age 2)
  - Eating the main meal in a room without a dining area (ages 2 and 5)
  - Skipping breakfast (age 5)
  - Use of a local take-away (age 6)
- Sedentary behaviour related to
  - TV in the child's bedroom
  - Screen time from sweep 4 onwards
- Low levels of parental supervision

Parental factors that were not significantly associated with children's overweight and/or obesity at age 6 are not shown in Table 3.3. These included parental sedentary behaviour and exercise, children's pattern of eating at age 2 (snacking between meals, composition of snacks), children's fruit and vegetable consumption, children's soft drink consumption, children's frequent eating of sweets and crisps at age 5, frequent use of a take-away, restaurant or convenience food for main meal at ages 3 and 5, children's physical activity, children's sleeping duration, patterns and problems; as well as most aspects of general patterns of parenting including warmth, joint parent-child activities, rules, household chaos and conflict.

**Table 3.3 Parental factors associated with children's overweight and obesity at age 6, results of bivariate analyses**

		% overweight	p	% obese	p	Bases	
						Wtd	Uwtd
<b>Parental example</b>							
Mother's BMI (sweep 6)	Underweight or healthy	16	***	5	***	1147	1200
	Overweight	22		10		808	845
	Obese	29		14		619	606
<b>Health-related practices - nutrition</b>							
Breastfeeding duration (age 1)	None	24	NS	11	***	1147	973
	<4 months	21		8		1210	1329
	4 months plus	20		6		578	689
Introduction of solids (age 1)	<4 months	28	**	12	†	434	384
	4 months or later	21		9		2498	2603

Table continues over the page

**Table 3.3 Parental factors associated with children’s overweight and obesity at age 6, results of bivariate analyses (contd.)**

		% over-weight	p	% obese	p	Bases	
						Wtd	Uwtd
Crisps - frequency (age 2)	Once a week or less	17	*	5	*	538	585
	More than once a week but not every day	23		9		1079	1139
	Daily	24		11		975	966
	More than once daily	24		10		342	301
Sweets - frequency (age 2)	Once a week or less	17	*	4	**	628	685
	More than once a week but not every day	24		10		1070	1136
	Daily	22		11		888	870
	More than once daily	25		10		347	299
Where child eats main meal (age 2)	Kitchen/dining room/combined living and dining room	20	*	8	*	1784	1994
	Other room (living room, bedroom, other)	25		11		1031	880
Eats breakfast (age 5)	Yes	22	†	9	***	2791	2860
	No	29		19		144	131
Where child eats main meal (age 5)	Kitchen/dining room/combined living and dining room	20	***	8	***	1901	2109
	Other room (living room, bedroom, other)	27		13		928	793
Use of local take-away/fast food outlet (age 6)	I don't use it	16	*	7	NS	314	345
	I use it sometimes	23		10		2046	2073
	I use it often	22		8		364	330
	There isn't one in this area	22		7		211	243
TV in bedroom (age 4)	Yes	24	*	10	*	1332	1180
	No	21		8		1574	1783
TV in bedroom (age 5)	Yes	25	***	11	***	1512	1368
	No	19		7		1414	1613
Weekday TV time (age 4)	None	21	*	9	*	152	165
	Up to 30 minutes	16		6		78	84
	30 minutes to 1 hour	21		9		155	170
	1 to 2 hours	21		8		1120	1189
	2 to 3 hours	25		11		843	852
	3 to 4 hours	21		7		319	297
	4 to 5 hours	21		9		130	115
	5 or more hours	34		17		104	86
Weekday screen time (age 5)	Under 1 hour	20	*	8	NS	279	314
	1 to under 2 hours	19		8		876	956
	2 to under 3 hours	22		9		904	918
	3 to under 5 hours	26		11		691	656
	5 hrs plus	23		13		157	125
Weekday screen time (age 6)	Under 1 hour	19	*	8	†	190	212
	1 hr to under 2 hours	19		7		734	803
	2 hrs to under 3 hours	24		9		744	757
	3 hrs plus	25		11		763	698
<b>General patterns of parenting</b>							
Supervision (age 4)	Low	27	*	15	***	568	534
	Medium - low	21		8		923	908
	Medium - high	21		7		1015	1065
	High	21		9		430	485

Notes: p=probability of difference between groups based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001.

# GROWING UP IN SCOTLAND:

Overweight, obesity and activity

## 3.5 Exploration of family and neighbourhood constraints associated with children's overweight and obesity

Distal (background) family and neighbourhood constraints on children's healthy weight identified as having statistically significant individual associations with children's overweight and/or obesity at sweep 6 (see Table 3.4 and Table 3.5) included:

- Lower maternal education (below HNC/HND)
- Biological father not present in household
- Bottom 40% of average household income
- Poor maternal physical health over sweeps 1, 3 and 5
- Maternal smoking (pregnancy, sweep 1)
- Area deprivation (two most deprived quintiles)

These findings suggest social inequalities in the patterning of children's overweight and obesity. As in the previous section, note that these associations do not take account of possible confounding influences.

Other possible family and neighbourhood constraints examined (mother's working hours, mother's mental health and urban-rural area) were not clearly associated with children's overweight and obesity (and are not included in Table 3.4 and Table 3.5).

Proximal family and neighbourhood constraints significantly associated with children's overweight and obesity (see Table 3.4 and Table 3.5) included:

- Cost affecting mother's preparation of food (age 5, but not age 2)
- Mother's feelings of personal safety when out alone by day and night (age 4 but not age 6)
- Child-friendliness of neighbourhood (age 4, but not age 6)
- Antisocial behaviour problems in neighbourhood (age 6)

Proximal family factors that did not show clear protective effects in helping to prevent children's overweight or obesity included mothers' views on desirable levels for children's physical activity and concerns for the child's weight.

Proximal neighbourhood factors not clearly associated with children's overweight and/or obesity (and not shown in Table 3.4 and Table 3.5) included access to local facilities such as a garden, playpark, local swimming pool or green space and the quality or safety of playparks.



**Table 3.4 Family constraints associated with children's overweight and obesity at age 6, results of bivariate analyses**

		% overweight or obese	p	% obese	p	Bases	
						Wtd	Uwtd
<b>Distal family factors</b>							
<b>Mother's education</b>	Up to Standard Grades or equivalent	23	*	11	**	1104	936
	Higher Grades or equivalent	25		11		649	669
	Upper level VQs (e.g. HNC, HND)	20		7		370	400
	Degree or equivalent	19		6		805	980
<b>Biological father in household (ages 1-5)</b>	Not present throughout	25	†	12	**	850	640
	Present throughout	21		8		2086	2352
<b>Household income (equivalised, average quintile, ages 1-5)</b>	Top 60%	21	NS	7	**	1499	1784
	Bottom 40%	23		11		1421	1194
<b>Mother's physical health (ages 1,3 and 5)</b>	Poor	26	**	11	**	995	980
	Medium	22		9		1003	1022
	Good	19		7		929	984
<b>Smoked in pregnancy</b>	No	22	NS	8	**	2222	2396
	Yes	24		12		703	586
<b>Proximal family factors</b>							
<b>Mother affected by food costs (age 5)</b>	A lot	29	NS	19	*	94	74
	A fair amount	24		11		251	242
	A little	23		9		881	899
	Not at all	21		8		1710	1777

Notes: p=probability of difference between groups based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001.

**Table 3.5 Neighbourhood constraints associated with children's overweight and obesity at age 6, results of bivariate analyses**

		% overweight or obese	p	% obese	p	Bases	
						Wtd	Uwtd
<b>Distal neighbourhood factors</b>							
<b>Area deprivation (SIMD quintile)</b>	1 least deprived	20	NS	7	*	576	697
	2	20		7		615	706
	3	22		8		566	618
	4	26		11		552	511
	5 – most deprived	23		12		627	459
<b>Proximal neighbourhood factors</b>							
<b>Neighbourhood safety (age 4)</b>	High	22	NS	8	**	1886	2021
	Low	23		11		1049	970
<b>Child friendly neighbourhood (age 4)</b>	Good	20	*	8	**	1102	1238
	Average	23		7		760	795
	Poor	24		12		1073	958
<b>Antisocial behaviour in area last year (age 6)</b>	None	22	NS	8	*	1503	1638
	One	21		8		625	640
	Two	22		9		295	296
	Three	22		8		197	183
	Four or more	25		15		312	233

Notes: p=probability based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\* p<0.01, \*\*\*p<0.001.

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## 3.6 Multivariate modelling of factors associated with children's overweight and obesity at age 6

More sophisticated analyses examined associations between parenting, family and neighbourhood factors and children's overweight and/or obesity, controlling for various factors simultaneously. This section reports the main findings of multivariate analyses using logistic regression models of children's overweight (including obese) and obese at age 6. Detailed results are provided in the Technical Appendix. The reference group for the model of overweight was all children with healthy weight plus the small number of underweight children. In the obesity model, this reference group in addition included overweight children.

Several of the potential risk factors were highly correlated with one another. These included TV in bedroom with high screen time, consumption of crisps with consumption of sweets, child-friendliness of neighbourhood with low perceived safety and antisocial behaviour problems, and eating in a room not primarily designed for food consumption with use of a local takeaway. Exploratory models to assess the strength of different effects was used to guide further selection of variables for the multivariate models. Bedroom TV, child-friendliness of the neighbourhood and eating in a room without a dining area were selected<sup>11</sup>. Snacking on sweets and crisps were combined to create a composite measure of snacking on both foods.

Children's overweight and obesity at age 4 was not included in the models, although as section 3.2.3 showed, children's BMI classification at age 4 was a very strong predictor of overweight and obesity two years later.<sup>12</sup>

All modelling controlled for the child's gender and their age in months at the sweep 6 interview, ethnic group, birthweight, and number of children in the family. In respect of these standard controls for child characteristics and family size, all models found a significant effect of:

- higher birthweight on an increased likelihood of overweight or obesity
- being in a family with four or more children on a reduced likelihood of being overweight or obese

There were no statistically significant differences in overweight or obesity according to the child's gender, age at sweep 6 interview or ethnic group (white/minority).

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11 Similar results were obtained in alternative models not shown here, which substituted screen time and fast food consumption for (respectively) bedroom TV and eating in a room without a dining area. However, child-friendliness of the neighbourhood proved a stronger predictor of children's obesity in multivariate models than either neighbourhood safety or antisocial behaviour problems.

12 Note that if we included sweep 4 BMI, we would have been measuring *change* in BMI status in the models. However, we did not have two complete sets of potential risk factors, measured before and after sweep 4. In the interests of simplicity, it was decided to focus solely on the sweep 6 measures of overweight and obesity.

Various stages of modelling looked at the separate influences of parenting and of family and neighbourhood constraints (see the Technical Appendix for details). A combined model was then used to examine all factors simultaneously. In this combined model the following factors emerged as significantly associated with children’s overweight and obesity (summarised in Figure 3.4):

- Mother’s overweight or obesity
- Frequency of sweet and crisp consumption as a toddler
- Mother’s poor physical health

Additional factors associated with children’s overweight (including obesity) were:

- Eating main meal in a room without a dining area

Additional factors associated with children’s obesity were:

- Low parental supervision
- Skipping breakfast
- Low child-friendliness of neighbourhood

**Figure 3.4 Summary of risk factors for children’s overweight and/or obesity at sweep 6: results of final multivariate modelling**

		Overweight and obesity	Obesity
Child characteristics	Higher birthweight	+	+
	Four or more children	-	-
Family and neighbourhood constraints on healthy weight management	Mother’s poor physical health	+	+
	Neighbourhood not ‘child friendly’		+
Parental factors	Mother overweight or obese	+	+
	Eating sweets and crisps once a week or less	-	-
	Skips breakfast		+
	Doesn’t eat main meal in room with dining area	+	
	Low parental supervision		+

Note: Shaded areas indicate increased or decreased risk of either overweight and obesity, or obesity. Model adjusted for all factors together, see Tables 1.1 and 1.2 in the Technical Appendix for further details

## PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOUR

### 4.1 Key findings

- 15% of children exercised for less than the recommended level of 60 minutes daily, and 31% of children had 3 or more hours of screen time on a typical weekday.
- Children who were less physically active at age 6 were likely to have been less active when they were younger. Similarly, high sedentary behaviour as measured by screen time at age 6 reflected earlier high levels of screen use.
- However, it did not appear that high levels of screen time led to lower physical activity, or vice versa. The two behaviours appeared to have different sets of associated factors at age 6.
- Factors associated with low physical activity included winter season, child characteristics (being an only child, minority ethnic group), maternal characteristics (lower concern for and modelling of physical activity), neighbourhood characteristics (no swimming pool) and a less warm mother-child relationship.
- High screen time was more common in boys, in families with lower socio-economic status (low maternal education, mother smoking) and in neighbourhoods with poor quality local green spaces. High screen time was also associated with mothers' own screen use and a TV in the child's bedroom. General parenting was also involved, as screen use was greater in families where mothers did fewer activities with their children or had fewer rules for the child's behaviour.
- Being overweight or obese at age 4 was not a risk factor for either low physical activity or high screen time at age 6.

### 4.2 Levels of physical activity and sedentary behaviour at age 6

According to mothers' reports, most children (85%) at age 6 met UK recommended targets for at least 60 minutes of moderate to vigorous physical activity every day (Table 4.1). 15% of the children were exercising for less than the recommended target. There was only a small increase in this figure (to 16%) when school-based activities were excluded. The proportion of children exercising for less than 60 minutes daily in the GUS data set was lower than found in the 2010 Scottish Health Survey (SHeS). Taking school-based activity into account, the SHeS found that 27% of 5-7 year-olds exercised for less than the recommended amount. Excluding school-based activities, this figure rose to 37% of 5-7 year olds (Marryat 2011)<sup>13</sup>.

There are no firm guidelines for sedentary behaviour in children, except that it should be limited. Most children (61%) watched TV and/or used a computer or games console for between 1 and 3 hours on a weekday, with just under a third using screens for 3 hours or

<sup>13</sup> These differences are unlikely to reflect methodology, as questions on physical activity were similar in GUS and SHeS. The discrepancy might be due to differences in sample populations and/or measurement error in parental estimates.

more (Table 4.1). At the weekend, levels of children’s screen use were higher, with around half the sample using screens for 3 hours or more on a Saturday. The SHeS did not have a measure of sedentary behaviour to compare with the GUS measure.

**Table 4.1 Levels of physical activity and screen time in the age 6 sample**

		%	Bases	
			Wtd	Uwtd
<b>Physical activity including school-based activity</b>	60+ min on all 7 days	86	2512	2581
	30-59 min on all 7 days	8	230	225
	Lower level of activity	7	191	184
	Total	100	2933	2990
<b>Physical activity excluding school-based activity</b>	60+ min on all 7 days	83	2432	2497
	30-59 min on all 7 days	8	245	245
	Lower level of activity	8	243	236
	Total	100	2920	2978
<b>Weekday screen time</b>	Under 1 hour	8	190	212
	1 hour to under 2 hours	30	734	803
	2 hours to under 3 hours	31	744	757
	3 hours plus	31	763	698
	Total	100	2431	2470
<b>Saturday screen time</b>	Under 1 hour	8	198	201
	1 hour to under 2 hours	16	394	421
	2 hours to under 3 hours	24	575	608
	3 hours plus	52	1248	1228
	Total	100	2415	2458

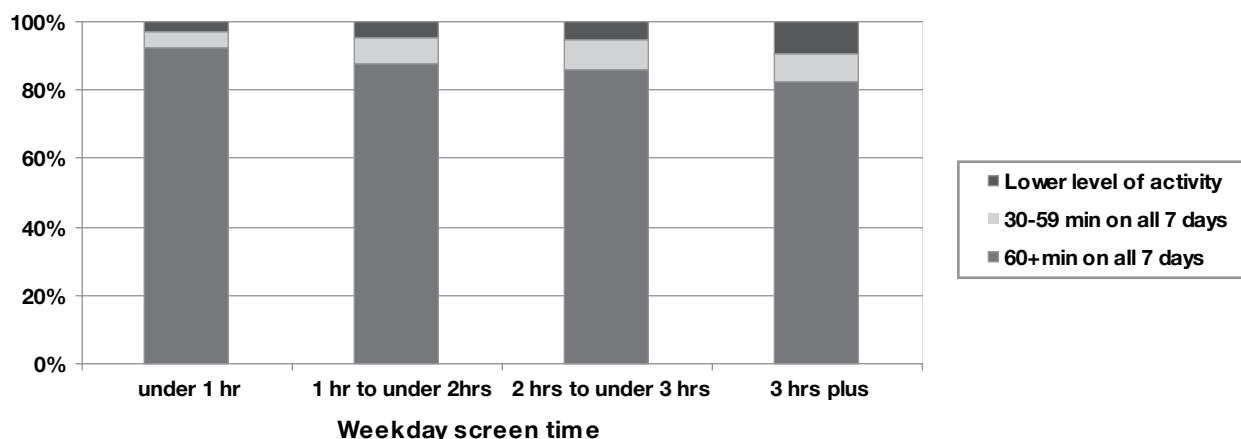
Note: Due to rounding, percentages may not sum to 100.

### 4.3 Are sedentary behaviour and physical activity interrelated at age 6?

Children with higher levels of screen time were less likely to meet recommended targets for 60 minutes a day of moderate to vigorous physical activity at age 6 (see Figure 4.1 A and Figure 4.1 B). However, even among those children with screen time of 3 hours or more on a weekday, the majority (83%) still met the target.

**Figure 4.1 Associations between weekday and Saturday screen time and physical activity level at age 6**

A Weekday screen time

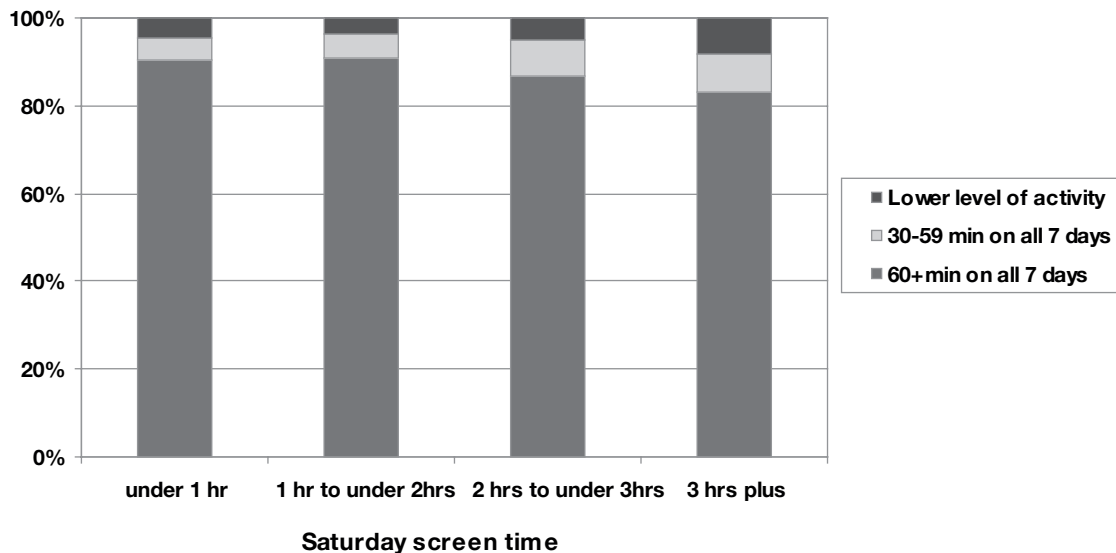


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**Figure 4.1 Associations between weekday and Saturday screen time and physical activity level at age 6 (contd.)**

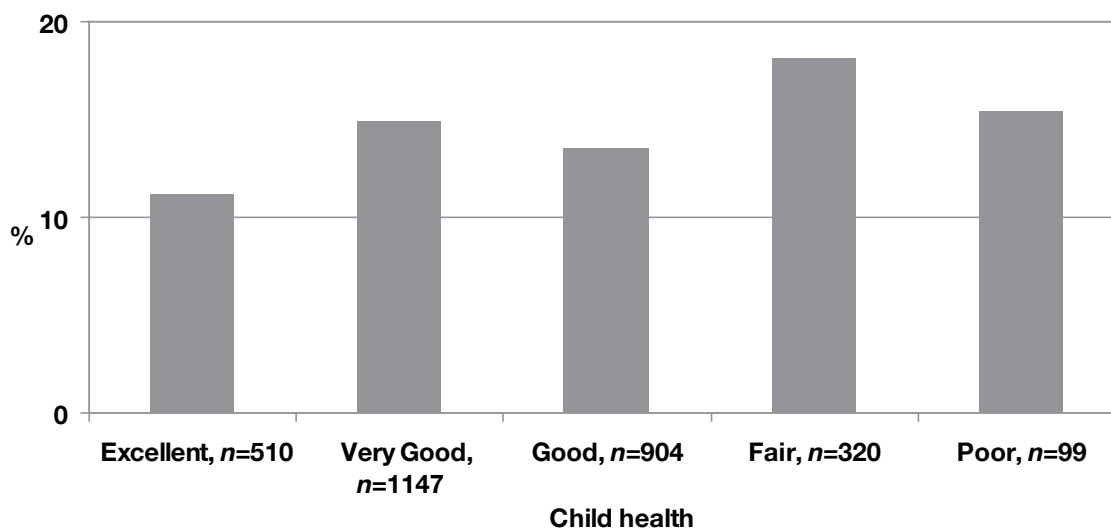
B Saturday screen time



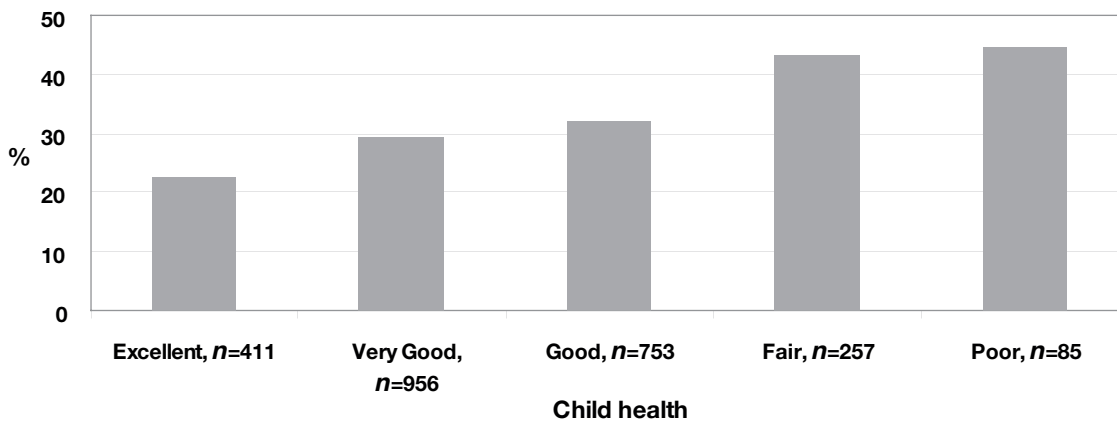
## 4.4 Associations between activity levels and children’s health

Physical activity did not vary systematically according to the child’s general health (as reported by mothers at age 6), see Figure 4.2. However, children with poorer health had higher levels of screen time, see Figure 4.3.

**Figure 4.2 Percentage of children with low (< 60 minutes daily) physical activity according to child’s health at age 6**



**Figure 4.3 Percentage of children with high (3+ hours weekday) screen time according to their health at age 6**

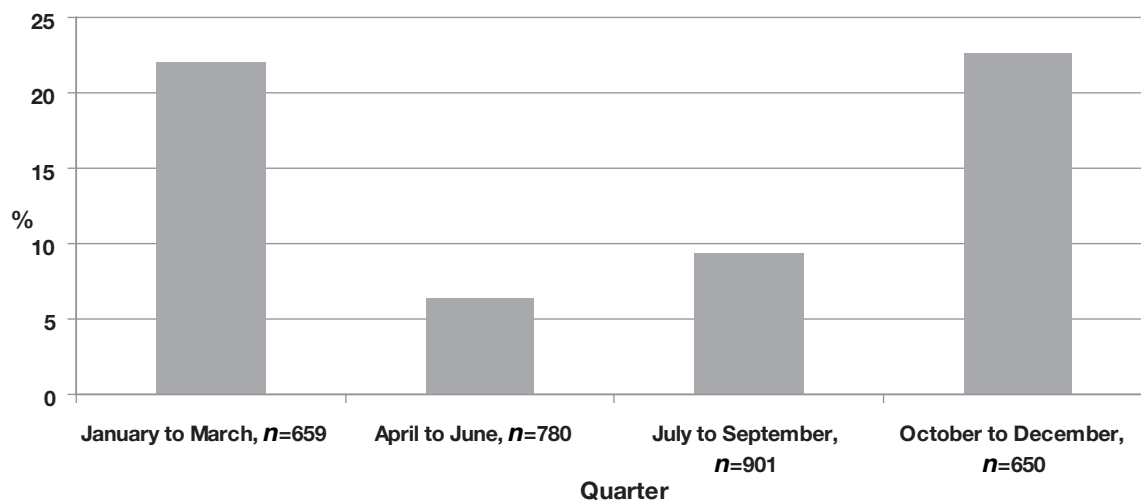


#### 4.5 Associations between activity levels and season of the year

Children were physically active for longer periods in the second and third quarters of the year, when longer daylight hours permit more outdoor activity (Figure 4.4).

Use of screens showed less seasonal variation than physical activity, but was highest in the first, third and fourth quarters of the year (Figure 4.5). High screen time in the third quarter is likely to reflect increased leisure time during the school summer holidays in July and August.

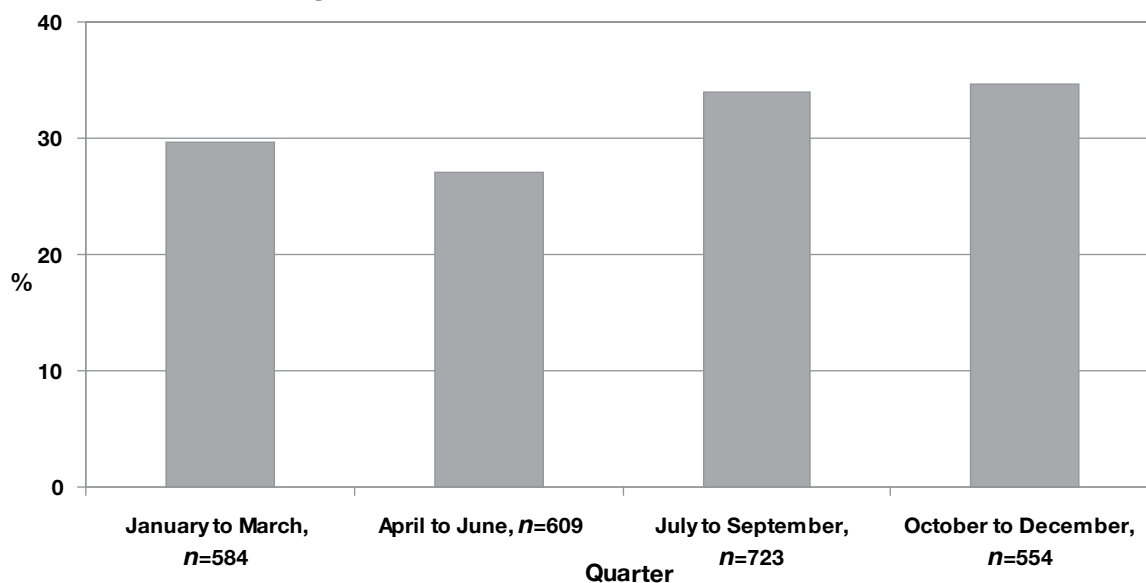
**Figure 4.4 Percentage of children with low (< 60 minutes daily) physical activity according to quarter of the year surveyed at age 6**



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**Figure 4.5 Percentage of children with high (3+ hours weekday) screen time according to quarter of the year surveyed**



## 4.6 Associations between age 6 activity levels and overweight or obesity

Current physical activity levels did not show clear associations with overweight or obesity at age 6 (Table 4.2). Further investigation with more sensitive measures (total minutes per week in all activities) also failed to find an association with overweight and obesity.

Screen time was not associated with overweight and obesity. Again, further investigation of weekend screen time allowing two further extended exposure categories of between 5 and 7 hours (13% of the sample) and 7 or more hours (5% of the sample) also failed to find an association with overweight and obesity.

Although there were no clear associations between either individual activity measure and overweight/obesity, it is possible that children who were less physically active AND used screens for long periods were most at risk. However, further investigation did not support the view that a combination of low activity and high sedentary behaviour, at age 6, is associated with greater risk of being overweight and/or obese (not shown here).



**Table 4.2 Physical activity and sedentary behaviour at age 6: associations with age 6 overweight and obesity**

		% Overweight	% Obese	Bases	
				Wtd	Uwtd
<b>Physical activity including school-based</b>	60+ min on all 7 days	23	9	2512	2581
	30-59 min on all 7 days	20	7	230	225
	Lower level of activity	20	9	191	184
<b>Physical activity excluding school-based</b>	60+ min on all 7 days	23	9	2432	2497
	30-59 min on all 7 days	20	8	245	245
	Lower level of activity	21	9	243	236
<b>Weekday screen time</b>	Under 1 hour	19	8	190	212
	1 hour to under 2 hours	19	7	734	803
	2 hours to under 3 hours	24	9	744	757
	3 hours plus	25	11	763	698
<b>Saturday screen time</b>	Under 1 hour	18	8	198	201
	1 hour to under 2 hours	23	8	394	421
	2 hours to under 3 hours	20	9	575	608
	3 hours plus	24	10	1248	1228

Note: No differences between groups were statistically significant. Note that associations are measured separately for each factor and do not control for other influences.

A recent UK study found that being overweight led to lower physical activity in children (Metcalf et al. 2011). We also explored whether overweight and obesity at age 4 was associated with later physical activity and sedentary behaviour at age 6. We did not find that children in the GUS sample who were overweight or obese at age 4 adopted different activity patterns from their healthy weight peer group two years later (not shown).

#### 4.7 Exploration of factors associated with age 6 physical activity and sedentary behaviour

This analysis focused on two outcomes:

1. Low physical activity (defined as not meeting recommended guidelines of at least 60 minutes every day, including school-based activity)<sup>14</sup>
2. High weekday sedentary behaviour of 3 hours or more screen time<sup>15</sup>.

Associations explored in this section do not take account of possible confounding influences (other factors that simultaneously may play a role).

14 Although for simplicity we present findings for a measure that includes school-based activity, analysis with a measure excluding school activities gave similar results.

15 This cut-off was chosen to reflect increased obesity risk, while being sufficiently discriminatory (imposing a lower cut-off of say 2 hours would include around half of the sample in the "high screen time" group). The weekday rather than Saturday measure has been selected because of its likely greater implications for reduced time spent on physical activity, and because of its clearer association with overweight and obesity.

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## 4.7.1 Child and family characteristics associated with physical activity and sedentary behaviour

Girls and boys were equally likely to meet physical activity targets at age 6, but boys were more likely than girls to spend longer periods using screens. Lower levels of physical activity were seen in children from minority ethnic groups, but there were no ethnic differences in screen time. Children without any siblings had lower physical activity than those from larger families. There appeared to be a U-shaped relationship between the number of children in the family and screen use. The only child, and those in larger families had greater levels of screen time than children with one or two siblings (Table 4.3).

**Table 4.3 Child and family characteristics associated with physical activity and sedentary behaviour at age 6**

		Not active for 60 mins/day (including school activity)				Screen time 3+hours weekday			
		%	p	Bases		%	p	Bases	
				Wtd	Uwtd			Wtd	Uwtd
<b>Gender</b>	Male	14	NS	1500	1519	34	**	1293	1306
	Female	14		1433	1471	28		1137	1164
<b>Child's ethnic group</b>	White	14	***	2812	2890	31	NS	2333	2390
	Minority	30		120	99	35		97	79
<b>Children in household</b>	One	19	*	584	551	35	*	482	454
	Two	13		1537	1642	29		1293	1373
	Three	14		621	635	31		507	519
	Four +	12		192	162	39		148	124
<b>Birth order</b>	First born	16	*	1471	1444	32	NS	1194	1162
	Other children	13		1462	1546	30		1236	1308

Notes: p=probability based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001. Note that associations are measured separately for each factor and do not control for other influences.

## 4.7.2 Parental factors associated with physical activity and sedentary behaviour

### Parental modelling

Parental modelling of specific behaviours appeared to be important. There were strong associations between mothers' physical activity at sweep 5 and children's physical activity at age 6. There were also strong associations between between mothers' screen time at sweep 5 and children's screen time at age 6 (Table 4.4). However, mothers' screen time did not predict children's physical activity, nor conversely did mothers' physical activity predict children's screen time.

Mothers' overweight or obesity at age 6 was not associated with children's physical activity or sedentary behaviour (not shown).

**Table 4.4 Associations between parental modelling and children's physical activity and sedentary behaviour at age 6**

		Not active for 60 mins/day (including school activity)				Screen time 3+hours weekday			
		%	<i>p</i>	<i>Bases</i>		%	<i>p</i>	<i>Bases</i>	
				<i>Wtd</i>	<i>Uwtd</i>			<i>Wtd</i>	<i>Uwtd</i>
Mother's weekly physical activity sweep 5 (quintiles)	q1 - Bottom 20%	21	***	550	584	31	NS	462	484
	q2	17		623	646	29		512	533
	q3	11		452	478	28		369	391
	q4	10		528	541	28		445	455
	q5 - Top 20%	9		574	552	35		472	448
Mother's weekly screen time sweep 5 (tertiles)	Low	13	NS	926	1005	21	***	724	784
	Medium	13		978	1021	27		818	856
	High	17		1027	961	43		885	827

Notes: *p*=probability based on adjusted F where NS=not significant, † *p*<0.1, \**p*<0.05, \*\**p*<0.01, \*\*\**p*<0.001. Note that associations are measured separately for each factor and do not control for other influences.

### Health-related practices

Earlier measures of children's physical activity gathered at previous sweeps were associated with greater physical activity at age 6, but not with screen time at age 6. Frequency of visiting local green spaces (measured at age 6) was associated with both higher children's physical activity and reduced screen time (Table 4.5).

Children who had a TV in their bedroom at earlier sweeps and who spent a lot of time watching TV and/or playing with a computer or games console at earlier sweeps were more likely to use screens for 3 hours or more at age 6. However, there were no clear associations between earlier screen time and age 6 physical activity (Table 4.6).

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**Table 4.5 Associations between health practices related to active behaviour and children’s physical activity and sedentary behaviour at age 6**

		Not active for 60 mins/day (including school activity)				Screen time 3+hours weekday			
		%	p	Bases		%	p	Bases	
				Wtd	Uwtd			Wtd	Uwtd
<b>Weekly duration child’s active behaviour (sweep 3)</b>	Less than 1 hr	41	***	58	55	36	NS	46	44
	1 to under 3 hrs	25		251	253	35		211	209
	3 to under 5 hrs	21		544	537	36		454	445
	5 to under 7 hrs	15		604	620	29		505	519
	7 hrs plus	9		1446	1495	30		1191	1230
<b>Physical activity level sweep 5 (quintiles)</b>	q1 - Lowest 20%	28	***	601	593	35	NS	507	503
	q2	19		557	565	33		462	467
	q3	11		598	616	31		512	519
	q4	8		592	606	27		476	490
	q5 - Top 20%	6		579	601	29		469	484
<b>Frequency mother and child visit local green spaces/month (age 6)</b>	Every day	8	***	488	522	27	**	391	421
	Several times a week	12		747	784	30		615	644
	Once a week	16		569	578	30		478	482
	Several times a month	13		515	523	30		442	443
	Once a month	19		266	263	36		216	216
	Less often	22		217	200	40		179	163
	Not at all	27		130	119	45		109	100

Notes: p=probability based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001. Note that associations are measured separately for each factor and do not control for other influences.

**Table 4.6 Associations between earlier screen use and its related factors and children’s physical activity and sedentary behaviour at age 6**

		Not active for 60 mins/day (including school activity)				Screen time 3+ hours weekday			
		%	p	Bases		%	p	Bases	
				Wtd	Uwtd			Wtd	Uwtd
<b>TV in bedroom (sweep 5)</b>	Yes	14	NS	1511	1367	40	***	1288	1169
	No	15		1413	1612	21		1136	1294
<b>TV in bedroom (age 4)</b>	Yes	15	NS	1331	1179	41	***	1118	996
	No	14		1572	1782	23		1293	1458
<b>Hours watching TV on weekday (sweep 3)</b>	None	10	NS	15	18	<1	***	11	13
	Up to 30 minutes	14		299	311	23		229	236
	30 minutes to 1 hour	11		464	491	22		365	387
	1 to 2 hours	15		1015	1063	25		849	882
	2 to 3 hours	16		692	689	40		595	595
	3 to 4 hours	15		188	180	49		169	163
	4 to 5 hours	16		82	71	59		72	65
	5 hours or more	11		69	57	53		64	54
<b>Hours watching TV on weekday (age 4)</b>	None	13	NS	152	165	17	***	111	119
	Up to 30 minutes	11		78	84	11		59	63
	30 minutes to 1 hour	10		155	170	7		114	126
	1 to 2 hours	14		1120	1189	22		917	972
	2 to 3 hours	15		841	851	38		715	729
	3 to 4 hours	16		318	296	46		291	267
	4 to 5 hours	24		130	115	63		112	102
	5 hours or more	17		104	86	57		88	71
<b>Screen time weekday (sweep 5)</b>	Under 1 hour	11	NS	279	314	7	***	188	211
	1 to under 2 hours	14		875	955	14		684	746
	2 to under 3 hours	16		903	917	30		776	791
	3 to under 5 hours	15		691	656	50		618	590
	5 hours or more	11		157	125	65		145	116

Notes: p=probability based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\* p<0.01, \*\*\*p<0.001. Note that associations are measured separately for each factor and do not control for other influences.

# GROWING UP IN SCOTLAND:

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## General patterns of parenting

Aspects of connection, control and conflict were each associated with screen time at age 6. Connection and conflict were associated with physical activity (Table 4.7).

Mothers who had a warm relationship with their child, who engaged in many joint activities and who experienced low levels of conflict were more likely to have physically active children with relatively low levels of screen use. In addition, mothers who had rules to guide their children's behaviour and a more organised home environment were less likely to have children who spent long periods watching TV or playing electronic games.

Parental supervision did not have a clear association with physical activity, although there was a trend for low supervision to be associated with higher levels of screen use.

**Table 4.7 Associations between general patterns of parenting and children's physical activity and sedentary behaviour at age 6**

			Not active for 60 mins/day (including school activity)				Screen time 3+ hours weekday			
			%	p	Bases		%	p	Bases	
					Wtd	Uwtd			Wtd	Uwtd
<b>Connection</b>	Pianta warmth (quartiles) <sup>a</sup>	q1 - low	17	**	730	686	38	***	609	561
		q2 and 3	16		871	896	33		725	743
		q4 - high	12		1314	1392	26		1084	1154
	Mother-child joint activities (quartiles)	q1 - low	16	**	770	721	43	***	620	579
		q2	20		291	290	29		248	247
		q3	15		1089	1109	30		900	910
		q4 - high	10		783	870	23		663	734
<b>Control</b>	Supervision (quintiles) <sup>a</sup>	q1 - low	17	NS	568	534	36	†	471	445
		q2	14		921	906	31		758	741
		q3 and 4	14		1015	1065	31		853	897
		q5 - high	12		430	485	26		348	387
	Number of rules (quintiles) <sup>a</sup>	q1 and q2 - low	15	NS	1055	1017	40	***	897	867
		q3	15		759	788	30		613	633
		q4	13		846	904	25		694	741
		q5 - high	13		274	281	20		226	229
	Home chaos (quintiles)	q1 - low	15	NS	766	820	26	***	639	681
		q2	16		676	701	31		558	578
		q3	14		474	490	29		393	406
		q4	12		628	622	32		518	511
		q5 - high	16		390	357	46		323	294
<b>Conflict</b>	Pianta conflict (quintiles)	q1 - low	13	**	751	798	27	***	634	668
		q2	17		409	425	27		328	350
		q3	11		581	600	27		485	500
		q4	13		633	637	34		521	521
		q5 - high	18		540	513	42		449	419

Notes: p=probability based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001. Note that associations are measured separately for each factor and do not control for other influences. <sup>a</sup>Due to lack of subdivisions in measures, some percentiles are combined.

### 4.7.3 Distal family constraints on children's physical activity and sedentary behaviour

There appeared to be no clear social inequalities in the patterning of children's physical activity, according to the distal family constraints examined. There was a trend (bordering on statistical significance) for families on lower incomes and families where the mother had not worked to have lower physical activity levels.

In contrast, children's screen time varied strongly by factors at the family level. These suggest social inequalities in the patterning of children's sedentary behaviour. Children were more likely to use screens for 3 or more hours if their mother did not work, had a relatively low educational level, was a lone parent and had lower levels of household income. Children were also more likely to use screens for longer if their mother was in poor mental or physical health, or if their mother smoked when pregnant. However, mother's working hours were not clearly associated with greater screen use (Table 4.8).

**Table 4.8 Family distal constraints associated with children's physical activity and sedentary behaviour at age 6**

		Not active for 60 mins/day (including school activity)				Screen time 3+ hours weekday			
		%	p	Bases		%	p	Bases	
				Wtd	Uwtd			Wtd	Uwtd
<b>Maternal employment per week (sweep 5)</b>	35 hrs or more	11	NS	446	498	25	***	367	409
	16 to less than 35 hrs	14		1183	1271	27		994	1064
	Less than 16 hrs	14		307	351	24		251	284
	Not working	16		993	865	42		814	708
<b>Mother's education</b>	Up to Standard Grades or equivalent	15	NS	1102	934	44	***	923	782
	Higher Grades or equivalent	15		649	669	31		536	555
	Upper level VQs (e.g. HNC, HND)	12		370	400	25		316	340
	Degree or equivalent	13		805	980	17		648	787
<b>Biological father in household</b>	No	14	NS	849	639	43	***	682	507
	Yes	14		2085	2351	27		1749	1963
<b>Household income (quintiles)</b>	Top 60%	13	†	1499	1784	21	***	1242	1476
	Bottom 40%	15		1418	1192	40		1176	983
<b>Mother's occupational class</b>	Managerial and professional occupations	13	†	1066	1269	19	***	872	1035
	Intermediate occupations	16		570	604	30		475	507
	Small employers and own account workers	12		118	134	24		97	110
	Lower supervisory and technical occupations	9		163	155	36		137	127
	Semi-routine and routine occupations	16		883	746	45		734	623
	Never worked	22		132	81	47		115	67

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**Table 4.8 Family distal constraints associated with children’s physical activity and sedentary behaviour at age 6 (contd.)**

		Not active for 60 mins/day (including school activity)				Screen time 3+ hours weekday			
		%	p	Bases		%	p	Bases	
				Wtd	Uwtd			Wtd	Uwtd
<b>Mother’s age at birth of first child</b>	Under 20	15	NS	518	360	49	***	431	298
	20 to 29	15		1504	1496	31		1251	1242
	30 to 39	14		885	1099	22		728	903
	40 or over	16		27	35	30		21	27
<b>Mother’s mental health</b>	Poor	16	NS	1001	987	35	*	842	823
	Average	14		944	997	29		769	815
	Good	13		979	1000	30		812	827
<b>Mother’s physical health</b>	Poor	15	NS	995	980	35	*	814	797
	Average	15		1003	1022	29		839	860
	Good	13		927	982	30		771	808
<b>Mother’s smoking in pregnancy</b>	No	14	NS	2221	2395	26	***	1834	1968
	Yes	15		702	585	47		588	494

Notes: p=probability based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001. Note that associations are measured separately for each factor and do not control for other influences.

## 4.7.4 Proximal family constraints

We explored two family level constraints that might affect how mothers managed their child’s physical activity and sedentary behaviour. These were mothers’ awareness of current guidelines (“target levels”) for physical activity in children, and mothers’ concerns about their child’s weight.

### Mothers’ views on desirable amount of physical activity in children

At age 6, mothers were asked two questions about the desirable amount of physical activity for children:

- “How many days a week do you think children of [childname]’s age should do physical activity? Please include all moderate physical activity, including physical activity at school.”
- “On each of the days someone of [childname]’s age does moderate physical activity, how many minutes a day should they do it for it to be good for their health?”

These questions were asked *after* questions on the child’s actual physical activity had been completed. This helped to avoid the possibility of bias in the mothers’ responses to the physical activity measures, after raising the issue of desirable levels of physical activity.

Although most (84%) mothers thought their children should take moderate to vigorous physical activity every day, many mothers (57%) did not think children needed to exercise for at least 60 minutes or more each day.<sup>16</sup>

<sup>16</sup> This measure is best treated as a measure of what mothers thought was desirable, rather than measuring awareness of UK recommendations. Fieldwork was conducted during 2010-11. UK guidelines on physical activity were not published until 2011, although they were based on similar WHO recommendations published in 2010, see [http://whqlibdoc.who.int/publications/2010/9789241599979\\_eng.pdf](http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf)



Views on desirable levels of physical activity were not associated with mothers' education or occupational class. Mothers who thought children should exercise for at least 60 minutes daily were likely to exercise more themselves, as measured at sweep 5. Mothers with an overweight child and who did not recognise the child's overweight were less likely to think at least an hour of daily physical activity was desirable.

Mothers' views were associated with whether their child met the physical activity target at age 6, but not with their child's sedentary behaviour (screen time):

- 9% of children failed the target when their mother thought at least 60 minutes daily was desirable, compared to 18% when mothers thought less activity was sufficient
- levels of screen time of 3 hours or more on a week day were almost identical whether mothers gave a 60-minute target level for physical activity (32%) or not (31%)

### **Mothers' concerns about their child's weight**

At sweeps 4 and 6, mothers were asked: "How concerned are you about [childname]'s weight at the moment?" (with answers on a four-point scale of "not at all", "a little concerned", "quite concerned" and "very concerned"). Mothers were divided into those who were not at all concerned, and those who expressed some concern.

The GUS data do not appear to support the idea that mothers who are more concerned about a child's weight will encourage their child to exercise more and limit sedentary time watching television or using a computer.

There was no clear association between mothers' concern for their child's weight (measured at age 4 or age 6) and children's physical activity level at age 6. Mothers' concern was associated with greater sedentary behaviour: 42% of children with concerned mothers used screens for 3 or more hours, compared to 30% of children with unconcerned mothers ( $p < 0.001$ ). A similar effect was seen with mother's concern measured at age 4. These findings suggest that the child's weight and/or sedentary behaviour may have led to mothers' concern, rather than mothers' concern succeeding in limiting the child's sedentary behaviour.

### **4.7.5 Distal neighbourhood constraints on children's physical activity and sedentary behaviour**

Children had higher levels of screen use if they lived in an urban or small town setting rather than a rural setting, and if they lived in a deprived neighbourhood. However, meeting recommended physical activity levels was not clearly associated with these neighbourhood factors (Table 4.9).

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**Table 4.9 Distal neighbourhood constraints associated with children’s physical activity and sedentary behaviour at age 6**

		Not active for 60 mins/day (including school activity)				Screen time 3+ hours weekday			
		%	p	Bases		%	p	Bases	
				Wtd	Uwtd			Wtd	Uwtd
<b>Urban-rural</b>	Urban	15	NS	2027	1937	33	*	1693	1612
	Small town	12		370	407	33		307	339
	Rural	15		536	645	25		430	518
<b>Area deprivation quintile</b>	1 - least deprived	12	NS	576	697	20	***	482	578
	2	16		615	706	26		496	571
	3	14		565	617	29		461	506
	4	12		551	510	38		468	430
	5 - most deprived	17		627	459	43		524	384

Notes: p=probability based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\*p<0.01, \*\*\*p<0.001. Note that associations are measured separately for each factor and do not control for other influences.

## 4.7.6 Proximal neighbourhood constraints on children’s physical activity and sedentary behaviour

Social and physical aspects of the neighbourhood environment were explored in relation to children’s physical activity and screen use at age 6.

Lower “child-friendliness”, in terms of mothers’ ratings at sweep 3 of the local social and physical environment for children, was associated with failing to meet the physical activity target and with greater screen time at age 6. However, child friendliness measured at age 6 did not show a clear association with meeting the physical activity target at this age.

Some associations between access to local facilities and activity levels were found:

- access to a playground or park (sweep 2) and access to a pool at age 6 (but not sweep 2) were associated with age 6 physical activity
- access to a garden<sup>17</sup> was associated with lower screen time, but was not clearly associated with physical activity

Walking time to nearest green space (measured at age 6) was not associated either with physical activity or sedentary behaviour (not shown).

Greater screen time (but not physical activity) was also associated with a lower quality neighbourhood environment, in terms of:

- poorer quality of local green places
- concerns over safety of neighbourhood and local play areas
- greater levels of antisocial behaviour

<sup>17</sup> Access to a garden was reported by 90% of families at sweep 1.

**Table 4.10 Proximal neighbourhood constraints associated with children's physical activity and sedentary behaviour at age 6**

		Not active for 60 mins/day (including school activity)				Screen time 3+ hours weekday			
		%	p	Bases		%	p	Bases	
				Wtd	Uwtd			Wtd	Uwtd
<b>Garden (sweep 1)</b>	Yes	14	NS	2653	2767	30	***	2194	2283
	No	18		280	223	44		237	187
<b>Playground/park (sweep 2)</b>	Not in area	22	*	191	180	33	NS	155	148
	In area	14		2732	2802	31		2267	2316
<b>Swimming pool locally (sweep 6)</b>	Not in area	18	**	740	750	34	NS	617	625
	In area	13		2191	2238	31		1812	1844
<b>Rating of local green places to walk/sit (sweep 6)</b>	1 - highest	13	NS	1007	1139	23	***	809	912
	2	14		635	672	29		540	568
	3	17		596	582	37		508	496
	4	14		306	258	37		250	211
	5	13		161	150	45		131	122
	6	12		95	80	46		86	73
	7 - lowest	22		121	97	42		99	80
<b>Rating of safe places for children to play locally (sweep 6)</b>	1 - highest	12	NS	715	808	23	***	566	636
	2	16		641	695	26		534	579
	3	15		674	684	33		576	581
	4	14		379	344	40		333	301
	5	11		210	182	39		169	150
	6	16		136	121	43		120	105
	7 - lowest	21		166	144	40		126	111
<b>Neighbourhood safety (sweep 3)</b>	High	14	NS	1885	2020	29	***	1561	1663
	Low	16		1048	969	36		869	806
<b>Neighbourhood safety (sweep 6)</b>	High	14	†	1470	1604	26	***	1209	1315
	Medium	13		692	697	35		564	569
	Low	17		772	689	38		657	586
<b>Safe public play areas locally (sweep 3)</b>	Yes	14	NS	2020	2180	27	***	1655	1780
	No	16		885	783	40		751	667
<b>Neighbourhood antisocial behaviour problems (age 6)</b>	None	15	†	1501	1636	28	***	1233	1343
	1	11		625	640	29		518	531
	2	17		295	296	37		245	244
	3	19		197	183	43		174	159
	4 or more	12		312	233	41		258	191
<b>Child friendly neighbourhood (sweep 3)</b>	Good	13	*	1100	1236	27	***	906	1014
	Average	12		760	795	30		641	667
	Poor	17		1073	958	37		883	788
<b>Child friendly neighbourhood (age 6)</b>	Good	14	NS	965	1082	26	***	784	875
	Average	14		989	1042	31		846	888
	Poor	15		979	866	37		800	707

Notes: p=probability based on adjusted F where NS=not significant, † p<0.1, \*p<0.05, \*\* p<0.01, \*\*\*p<0.001. Note that associations are measured separately for each factor and do not control for other influences. Bases: WTD = weighted, UWTD = unweighted.

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## 4.8 Multivariate modelling of children's physical activity and sedentary behaviour at age 6

This section reports the main findings of multivariate analyses of children's low physical activity (below 60 minutes daily) and high sedentary behaviour (3 hours or more screen time on a weekday) at age 6.

Logistic regression models first investigated selected blocks of variables, before combining all factors in the final model. All models controlled for the child's gender, ethnic group, the number of children in the family, the child's general health and the season of the year when age 6 interviews took place. Detailed modelling results are provided in the Technical Appendix.

In the final model of physical activity, the following factors were significantly associated with the child exercising for less than 60 minutes daily:

- ethnic minority group
- being an only child
- winter season (October-March)
- no swimming pool in area
- mother's view that less than 60 minutes' daily physical activity was sufficient for children
- mother's lower level of physical activity
- less warmth in the mother-child relationship

In the final model of screen time, the following factors were significantly associated with the child using screens for three hours or more on a weekday:

- male gender
- low maternal education
- mother smoking in pregnancy
- poor quality local green spaces
- mother's greater screen time
- TV in the child's bedroom
- Fewer joint mother-child activities
- Fewer rules for the child's behaviour

These findings are summarised in Figure 4.6.

**Figure 4.6 Summary of risk factors for children's low physical activity and high screen time at age 6: results of final multivariate modelling**

		Low physical activity	High screen time
Child characteristics	Boy		
	Minority ethnic group		
	Only child		
Season interviewed	October to March		
Family and neighbourhood constraints on healthy weight management	Mother's lower education level		
	Mother smoked in pregnancy		
	Mother thinks less than 60 mins/day PA desirable		
	No local swimming pool		
	Poor quality rating local green spaces		
Parental factors	Mother less physically active		
	Mother higher screen time		
	TV in child's bedroom		
	Less warm mother-child relationship		
	Fewer joint activities shared by mother and child		
	Fewer parental rules		

Note: Dark shaded areas indicate associations with low physical activity and high screen time. Model adjusted for all factors together, see Technical Appendix for further details.

# MOTHERS' AWARENESS AND CONCERN FOR CHILDREN'S OVERWEIGHT

Parents who do not recognise that their child is overweight or obese are unlikely to help the child to lose weight. Research elsewhere has found that few parents seem to recognise overweight in their child (Parry et al. 2008; Jones et al. 2011a).

For the most part, this section focuses on the subgroup of GUS children who were defined as overweight or obese on the basis of their BMI at age 6. It explores the extent to which mothers recognised these children as overweight, and investigates factors associated with poor recognition and low levels of concern about children's overweight.

## 5.1 Key findings

- Few mothers recognised overweight or obesity, or expressed concern about an overweight child's weight. However, concern for the child's weight was markedly higher with correct identification of the child's overweight.
- Mothers were more likely to identify their child as overweight if the child was obese, rather than overweight. A mother was also more likely to identify a weight problem in a daughter, or if she was overweight herself.
- Correct identification of overweight at age 4 was not associated with the child losing weight by age 6, suggesting that helping mothers recognise overweight in children is not likely to be a sufficient solution to weight management.

## 5.2 What proportion of mothers recognised their child's overweight or obesity?

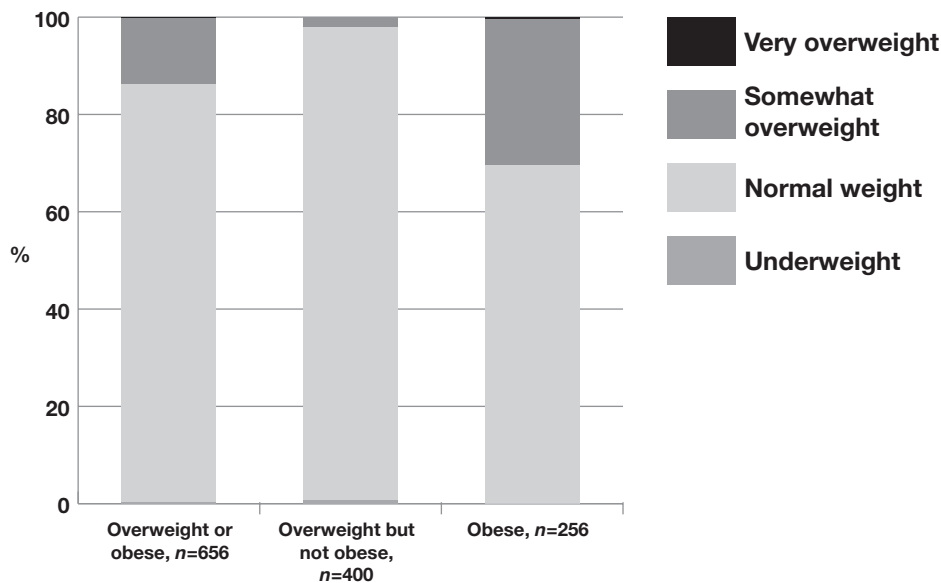
Mothers were asked to classify their child's weight using one of four options: underweight, normal weight, somewhat overweight or very overweight.<sup>18</sup>

Most mothers of children classified as overweight or obese at age 6 described their child as being of "normal" weight, with only 14% describing them as overweight (see Figure 5.1). Recognition of overweight was greater among mothers of obese children, but even among this group, around two-thirds described their child as being of normal weight.

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<sup>18</sup> Note that with the increased prevalence of overweight and obesity in children, mothers' perceptions of overweight as a "normal" condition have some justification. With hindsight, it might have been preferable to have used the term "healthy weight" as a response option, rather than "normal weight".

**Figure 5.1** Mother's description of their child's weight, according to the child's BMI classification at age 6



### 5.3 What proportion of mothers recognised their own overweight?

Mothers appeared more able to recognise overweight in themselves than in their child. Most mothers who were classified as obese or overweight on the basis of their BMI at age 6 identified themselves as either “somewhat” or “very” overweight. This included 70% of mothers who were overweight but not obese, and 97% of obese mothers. Less than 2% of mothers who were overweight but not obese described themselves as “very” overweight, compared to 30% of obese mothers reporting they were “very” overweight.

### 5.4 Factors associated with mothers' failure to recognise children's overweight or obesity at age 6

We explored whether maternal overweight or obesity, and various socio-demographic characteristics, were associated with a failure to recognise children's overweight or obesity<sup>19</sup>. Maternal and family characteristics related to social deprivation were not clearly associated with non-recognition of overweight in children. However, mother's BMI, child gender and height all appeared to be associated with recognition of overweight.

#### 5.4.1 Mother's BMI classification and recognition of child's overweight

Mothers who were themselves overweight or obese at age 6 were more likely to recognise overweight or obesity in their children than mothers who were a healthy weight (Figure 5.2). Even so, two-thirds of overweight or obese mothers described their obese children as of normal weight (Figure 5.2 part B).

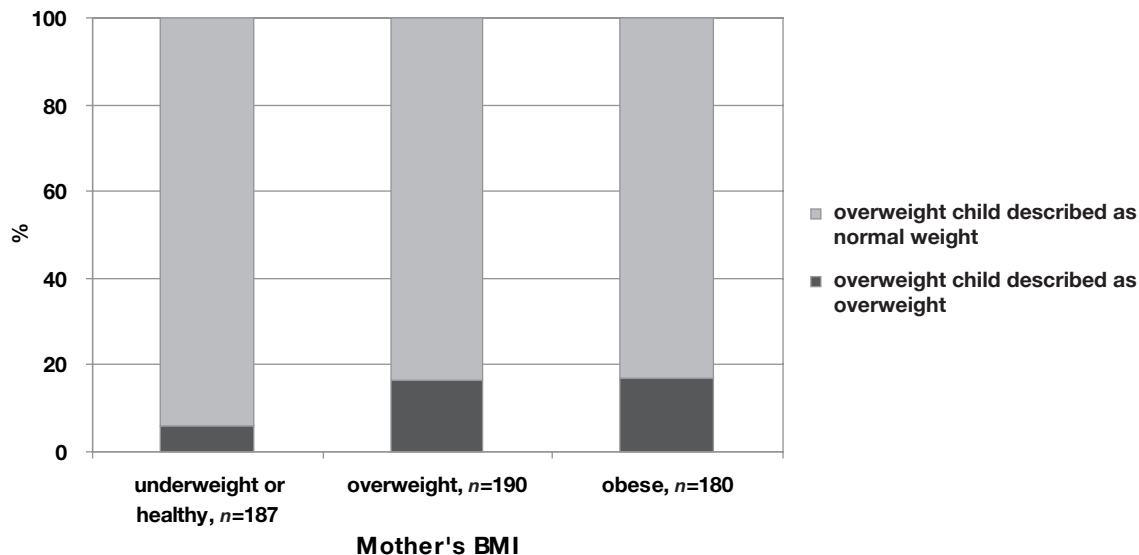
<sup>19</sup> Findings for obesity should be treated with caution due to small base samples.

# GROWING UP IN SCOTLAND:

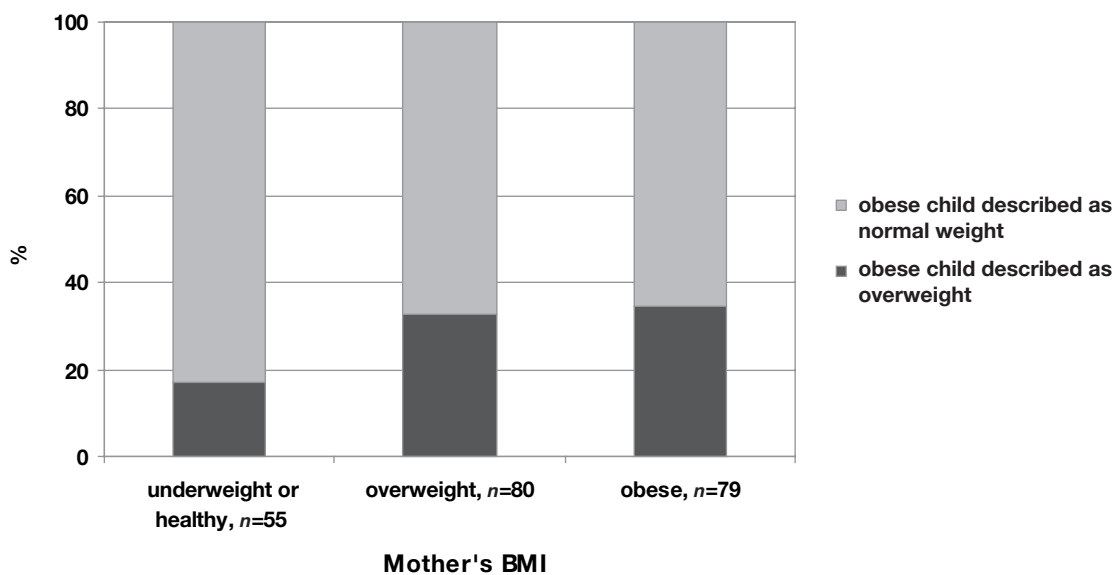
Overweight, obesity and activity

**Figure 5.2 Mother's description of overweight or obese children at age 6 according to mother's BMI classification**

A) Mothers with an overweight or obese child



B) Mothers with an obese child



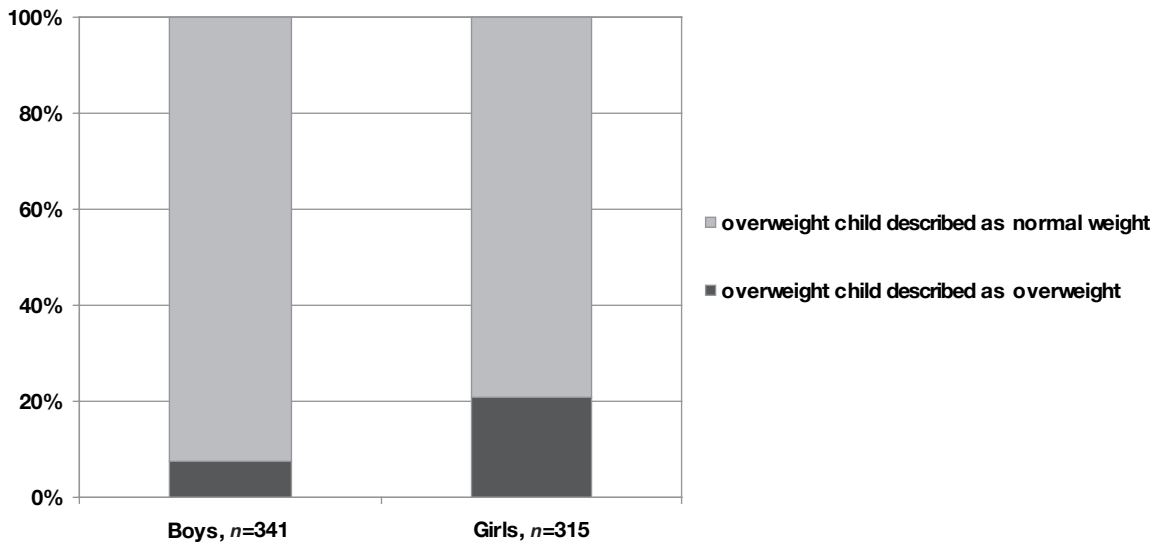


**5.4.2 Child characteristics associated with non-recognition of children's overweight or obesity: gender**

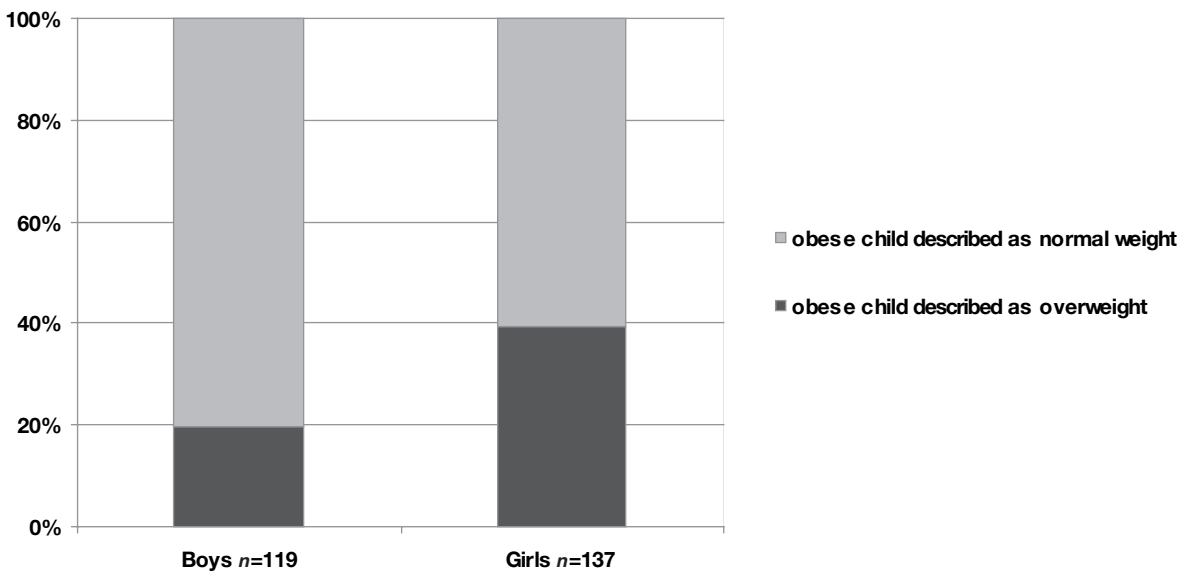
Mothers were less likely to recognise weight problems in boys compared to girls (Figure 5.3).

**Figure 5.3 Mother's description of overweight or obese children at age 6 according to child's gender, n=256**

A) Child BMI classified as overweight or obese



B) Child BMI classified as obese



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## **5.4.3 Multivariate model of factors associated with mothers' recognition of overweight in their child**

In sections 5.4.1 and 5.4.2, associations between various factors and mother's recognition of child overweight were examined individually. A multivariate model of mother's recognition allowed various influences to be examined simultaneously: these were the effect of child's BMI classification (overweight, obese or morbidly obese), gender and height, together with the mother's BMI classification as healthy weight, overweight or obese.

This model showed that amongst the subsample containing overweight or obese children, mothers were more likely to describe an overweight child as overweight if the child was obese or morbidly obese, if the child was a girl and if the mother was herself overweight<sup>20</sup>. The difference in description according to the child's gender has been found elsewhere (Vanhala et al. 2011).

We also examined factors associated with the mother's description of their child as overweight in the whole GUS sample – not just those cases where the child was overweight or obese – as other research has suggested that overweight mothers are less likely to describe a child as overweight (Layte and McCrory 2011; Parkinson et al. 2011). In the GUS data there was no evidence for a similar effect. Across the whole sample, mothers were more likely to describe a child as overweight if they were a girl, or if the child was classified as overweight or obese on the basis of BMI. Amongst mothers of all children, there was no significant effect of the mother's own BMI on a mother's description of a child as overweight.

## **5.5 Mothers' concerns about weight**

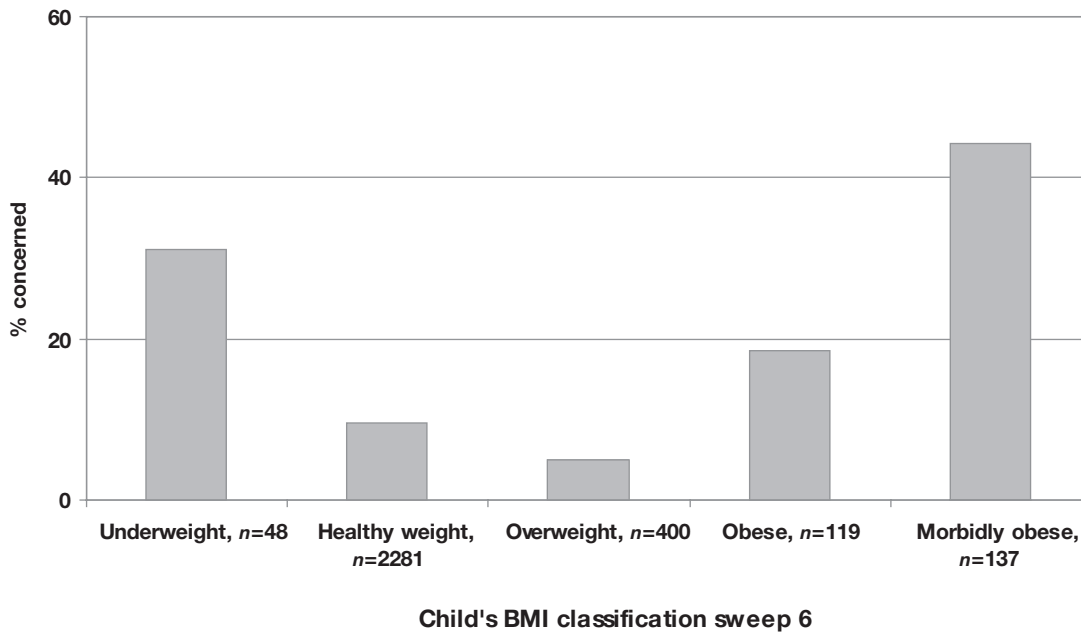
### **5.5.1 Mothers' concerns about their child's weight**

Across the whole GUS sample, mothers were more likely to express concern about their child's weight at age 6 if their child was underweight or obese (Figure 5.4). As with recognition of the child's weight, levels of concern were generally low. Only 5% of mothers of overweight children and 18% of mothers of obese children expressed concern, although 44% of mothers of morbidly obese children were concerned.

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<sup>20</sup> Further details provided on request.

**Figure 5.4 Mothers expressing concern about child's weight, according to child's BMI classification at age 6**



### **5.5.2 Association between mothers' recognition of child's overweight and concern**

Although mothers were asked about any concerns regarding the child's weight *before* they were asked to describe whether the child was overweight, mother's recognition of overweight was strongly associated with concern.

Only 6% of mothers who did not recognise that their child was overweight expressed concern about the child's weight. In contrast, among mothers correctly identifying a child as overweight, the vast majority (81%) expressed concern about the child's weight.

### **5.5.3 Mothers' concerns about their own weight**

Mothers' levels of concern about their own overweight were much higher than for their child's overweight. 70% of mothers who were overweight but not obese expressed some concern, although less than 2% were "very concerned" about their own weight. Among mothers who were obese, 88% were concerned, including 18% who were "very" concerned.

### **5.5.4 Factors associated with greater mothers' concern for overweight children**

Given that mothers who were overweight or obese themselves were more likely to recognise a child's overweight, and that higher recognition was apparently linked to greater concern, we might expect that overweight or obese mothers would be more concerned about their child's weight.

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In fact, levels of concern among mothers did not differ clearly according to whether a mother herself was overweight or not. Recognition levels were very low generally, and the effect of higher recognition on overweight mothers' concern was negligible. Mothers' concerns were also not clearly associated with factors linked to social deprivation.

Mothers of overweight children were more likely to worry about a girl's weight (24% were concerned) than a boy's weight (only 10% were concerned, gender difference statistically significant  $p < 0.001$ ).

## **5.6 Did mother's awareness of, and concern for, overweight at age 4 help their child to lose weight?**

A mother's recognition of her child's overweight and concerns in relation to this overweight may enable her to manage the child's diet and activity. We looked at whether identification of a child's overweight and mother's concern at age 4 was associated with weight loss by age 6.

Four in ten of children who were classified as overweight at age 4 were no longer overweight at age 6. However, this improvement in weight status was not associated clearly with a mother's recognition of child overweight at age 4, or with her concerns about the child's weight at this time.

A third (34%) of children whose mothers were concerned were no longer overweight by age 6, compared with 40% of those whose mothers did not appear concerned (difference not statistically significant). Moreover, 40% of mothers who incorrectly saw their child's overweight as "normal" at age 4 were no longer overweight by age 6, compared to 22% of mothers who correctly identified their child as overweight at age 4 ( $p < 0.05$ ).

The association between recognition and weight change appeared to be in the opposite direction to what might be expected from the predicted relationship between mother's recognition/concern and better weight management. It may be that mothers found it less easy to identify overweight in children who were borderline overweight at age 4, and that it was these children who were reclassified at age 6 as of healthy weight. Work elsewhere (Jones et al. 2011a) supports the idea that parents tend to use extreme models of overweight as a reference point.

## SUMMARY AND CONCLUSIONS

This section summarises the main findings, discusses some of the limitations of the study and reflects on implications for policy and practice.

The study focused on the identification of potentially modifiable factors associated with children's overweight and/or obesity, low physical activity and high sedentary behaviour at age 6. The report also investigated mothers' awareness of, and concern about, their child's overweight or obesity.

Children's weight and height were measured by trained researchers at age 6 (average age 5 years 10 months). Overweight or obesity were classified using BMI cut-offs derived from national population growth charts. In the GUS sample of 2,992 children, 22% were classified as overweight or obese, and 9% were obese.

Physical activity and sedentary behaviour were measured using mothers' reports of their child's behaviour. Physical activity was based on active behaviour outside school including walking, organised sport and exercise and active play during the past week, using separate questions about weekdays and weekends, together with all active behaviour (including walking) at school. Children were divided into those meeting or exceeding UK Government recommended levels of 60 minutes daily, and those below this target level. In the GUS sample, 15% of children exercised for less than the target of 60 minutes daily while the majority (85%) appeared to meet the target. Sedentary behaviour was based on mothers' reports of typical weekday screen time (watching TV or playing electronic games). Children were divided into those watching up to 3 hours daily (69%) and those watching for three hours or more (31%). Children who watched screens for 3 hours or more were slightly less likely to meet recommended levels of physical activity compared to children using screens for shorter periods.

Children's overweight and obesity from BMI measurements taken at age 4 (average age 3 years 10 months) were associated with a much greater chance of being overweight or obese at age 6, when compared to children who had a healthy weight at 4 years old. Despite this "tracking" of overweight and obesity from age 4 to 6, there was considerable movement out of the overweight and obese groups. Around four in ten children who were overweight or obese at age 4 were classified as having a healthy weight two years later. Half the children who were obese at age 4 were no longer obese at age 6, although most were still overweight.

Children's physical activity and sedentary behaviour measured at earlier sweeps predicted their physical activity and sedentary behaviour respectively at age 6. This suggests that habitual physical activity or sedentariness may develop at an early age. However, children who spent long periods using screens at young ages were not more likely to show low physical activity, and conversely low physical activity did not predict high screen use.

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Two main sets of possible influences on children's overweight/obesity and activity levels were considered: (1) parental factors, and (2) possible constraints on the child's healthy lifestyle related to family or neighbourhood factors.

Parental factors included mother's overweight and her modelling of active and sedentary behaviour; child health-related practices likely to be under the parent's control such as children's snacking on unhealthy foods or playing outdoors; and general patterns of parenting.

Family and neighbourhood constraints ranged from more "distal" or background factors (such as family income or area deprivation) to more "proximal" influences that might explain how some of the distal factors influenced either obesity or physical activity.

First, associations between separate individual risk factors and the outcome measures of children's overweight and/or obesity and children's activity levels were explored. Individual factors that had a statistically significant association with the outcomes were included in multivariate modelling, where it was possible to control for a number of influences simultaneously. The multivariate models also allowed for various child and family characteristics. These were gender, ethnicity, age in months at age 6, family size, birth weight (overweight/obesity models only), child health (activity models only) and season (activity models only).

## 6.1 Factors associated with children's overweight and/or obesity

There were no differences in child overweight and/or obesity according to the child's gender, or between white and ethnic minority groups. However, low numbers in minority ethnic groups did not permit further subdivision. The Millennium Cohort Study has oversampled minority ethnic groups to enable more finegrained analysis, and has found ethnic differences in children's overweight/obesity (Brophy et al. 2009). Within GUS, children with a higher birth weight were more likely to be overweight and/or obese at 6 years, as were only children, compared with those from large families (four or more children).

In the final multivariate models of children's overweight and/or obesity, significant parental influences included mother's overweight or obesity, dietary practices (consumption of sweets and crisps when a toddler, skipping breakfast, not eating the main meal in a dining area of the home), and low parental supervision.

Mothers who were overweight or obese were more than twice as likely as mothers of healthy weight to have obese children. The strong association between mother's overweight or obesity and children's BMI classification has been well established elsewhere. It may reflect one or more influences including an inherited predisposition to put on weight, epigenetic effects, continuation of the same environmental influences that led to a mother being overweight, and shared health practices related to diet and exercise (Wu and Suzuki 2006).

Conceptualising frequent consumption of sweets and crisps as an indicator of unhealthy early dietary practices comes with the cautionary note that the prevalence of overweight and obesity was significantly lower only for the minority (around 20%) of toddlers who were

given sweets and crisps once a week or less. The measure is therefore only useful as an indicator of children at lower risk of overweight and obesity, rather than predicting higher risk. Skipping breakfast was also found to be associated with 5-year-olds' overweight in the UK Millennium Cohort Study, and may reflect a more general association with poor dietary habits (Rampersaud et al. 2005).

Not eating the main meal in an area primarily designed for food consumption (either the kitchen, dining room or a combined living/dining room) could indicate eating more unhealthy foods, perhaps under less parental control. Low parental supervision could reflect lower maternal feelings of protectiveness as well as lower monitoring of a child's health-related behaviour. The finding appears to echo an effect of parental neglect on obesity found elsewhere (Lissau and Sorensen 1994; Whitaker et al. 2007; Knutson et al. 2010). Parental supervision was also found in an earlier GUS analysis to be important for other aspects of these children's health (Parkes and Wight 2011).

Many health-related practices suggested elsewhere as important for childhood overweight and obesity were not apparent in this study (Hawkins and Law 2006; Moreno and Rodriguez 2007; Monasta et al. 2010). These included maternal smoking, shorter duration or absence of breastfeeding, and early introduction of solids, although this report found that dietary practices later in childhood had a stronger effect. There was no effect of soft drink consumption or fruit and vegetable consumption as identified in some previous studies, nor of how often convenience or fast food was used for the child's main meal. There was also no effect of short sleep duration, low physical activity or high sedentary behaviour.

The analyses identified several constraints on children's healthy weight management, including poor maternal physical health and low "child-friendliness" of the neighbourhood. The effect of poor maternal physical health requires further investigation, and could be linked to longstanding overweight in mothers. Mother's BMI was only available at age 6, but other research has shown effects of pre-pregnancy overweight on children's obesity (Hawkins et al. 2009c; Wright et al. 2010). Low "child-friendliness" was based on mothers' assessments of the overall social and physical environment in which they were bringing up their child. It could reflect aspects such as neighbourhood safety, antisocial behaviour and the quality of local play areas and parks that individually had weaker associations with childhood obesity. The mechanism for any effect on obesity is unclear. It seems unlikely that child-friendliness is simply acting through features of the social and physical environment conducive to physical activity, since children's activity levels as measured in GUS did not have clear associations with obesity. Further research is needed using objective measures of neighbourhood quality, to see the extent to which mothers' perceptions are in line with these.

In preliminary modelling, small effects of low maternal education and area deprivation on increased risk of obesity were identified. However, these disappeared once infant feeding practices, eating crisps and sweets and neighbourhood child friendliness were included in the models. It appeared that the mechanism for the effect of low maternal education could be via poor dietary practices, while that for the effect of area deprivation could be low child-friendliness. There was no independent effect of maternal smoking in pregnancy on children's overweight and/or obesity, as found in some other research (Oken et al. 2008).

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## 6.2 Factors associated with children's low activity levels (physical activity and sedentary behaviour)

Although there were no gender differences in meeting the recommended 60 minutes' daily physical activity in the 6 year olds studied, boys were more likely than girls to use screens for 3 or more hours daily. Children from ethnic minority groups were more likely to have low levels of physical activity, but there were no differences between white and ethnic minority groups' screen time. More work is required to explore the ethnic difference in physical activity, with a sample containing higher numbers from different ethnic minority groups. Children from larger families were more physically active than only children, which might suggest the importance of play with other children for maintaining good levels of physical activity in children. We do not have information in the GUS survey on who does physical activities with the child, but other research has shown the importance of sibling as well as parental activity (Sallis et al. 2000b). Physical activity (but not screen time) varied strongly with daylight hours, indicating the importance of outdoor activities and (possibly) when children are able to walk or cycle to school more safely.

Children were more physically active if their mother was herself more active, had a warm relationship with the child and was more knowledgeable about desirable amount of physical activity for children. Lack of a nearby swimming pool was associated with lower overall physical activity.

Children used screens more if they had a TV in their bedroom, if their mother watched TV or used a computer a lot, or if their mother did fewer activities with the child and had fewer rules for the child's behaviour. Unlike children's physical activity, screen time increased with the level of social deprivation, as indicated by low maternal educational level, mother smoking in pregnancy and poor quality local green spaces. The effect of mother smoking in pregnancy on increased screen time has been identified elsewhere (Oken et al. 2008). The mechanism is unclear, but may be linked to social deprivation. More work is required using an objective measure of green space quality alongside mother's reports. It remains unclear whether providing more attractive green spaces would encourage both more activity and less sedentary behaviour, since the analysis for this report suggests the two behaviours are not closely linked.

## 6.3 Mother's recognition and concerns for their child's overweight

Mothers of an overweight or obese child were much more likely to describe the child as "normal" rather than overweight. Only 3% of mothers of overweight but not obese children described them as overweight, although recognition was higher when children were obese (30%). Mothers were also more likely to recognise overweight in a daughter than in a son.

Some previous work (Layte and McCrory 2011) has suggested that mothers who are overweight themselves are less likely to describe their child as overweight, once the child's objectively measured BMI has been allowed for. There was no evidence for this among mothers in the whole GUS sample, in agreement with another study (West et al. 2008). In the subsample containing overweight or obese children, mothers who were overweight or obese themselves were more, rather than less, likely to recognise overweight in their own child.



Mothers' recognition of overweight was associated with greater concern for the child's weight. Mothers' concern was greater if their overweight child was a girl rather than a boy, but did not appear to be linked to the mother's own weight.

These findings suggest that more could be done to increase mothers' understanding of what constitutes a healthy weight in young children. However, mothers' recognition and concerns for overweight at age 4 were not associated with child weight loss in the two-year period to age 6 BMI measurement.

### **6.3.1 Strengths and limitations of the study**

This study was able to examine a wide range of potential risk factors for overweight and/or obesity and low activity in a large sample of Scottish aged just under 6. The use of statistical techniques to counteract the effects of attrition in the GUS sample over the six sweeps of data collection helped to ensure that the findings are likely to be representative of the six-year-olds in the Scottish population.

Most, but not all, potential risk factors were measured in previous sweeps. This longitudinal element makes reverse causation less likely, but it is important to note that the associations found do not necessarily show causal relationships. Associations may be due to other confounding factors that have not been studied, including influences that predate the birth of the child. The study cannot distinguish between environmental and genetic effects that may be inherent in, for example, the association found between mother and child overweight.

The analysis presented in this report is limited by the type and detail of the questions included in GUS. Although children's and mother's BMI were based on researchers' measurements of weight and height, most other measures rely on mothers' reports. Mothers' reports may be subject to various biases, including social acceptability and positive or negative affect. Parent-reported activity measures may be unreliable, and overestimate children's habitual physical activity measured objectively using accelerometers (Basterfield et al. 2008). Screen time was used as a proxy measure for sedentary time. Self-report of activity rather than objective measurement might explain the lack of association between activity and children's BMI in this study.

The study did not include detailed dietary information on portion sizes and frequency, which would require the use of food diaries. Other relevant information was also not available. In the family, there was no information on partner's BMI classification (found elsewhere to be important in addition to maternal overweight, Whitaker et al. 2010), mother's BMI at earlier ages and mother's diet. In the wider community, missing information includes objective measures of neighbourhood facilities and safety issues, and school level factors. Recent studies looking at the spatial distribution of resources and facilities have found that people living in more deprived areas in Scotland have more resources such as outdoor play areas, sports centres and swimming pools close by than those living in affluent areas (Macintyre et al. 2008; Ogilvie et al. 2011).

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## 6.4 Policy implications

While more research could be done to supply more objective measures of some of the outcomes and risk factors, and to investigate causal mechanisms, this study has suggested a range of risk factors for young children's overweight and low activity, at both family and neighbourhood levels. These factors are potentially modifiable, or would at least allow risk groups to be identified. The "tracking" of child overweight and activity from earlier ages to age 6 suggests that early intervention may be most valuable.

The strong association between mother's own overweight and that of her child (well established elsewhere) and the importance of other parental factors suggest that interventions to reduce child overweight and obesity may be most successful if they treat the family as a unit, rather than focusing exclusively on the child's weight problem. Improving a mother's recognition and concern for her child's overweight is likely to be only a first step in tackling the problem, as greater awareness may not translate into better weight management without addressing other aspects of parental behaviour. For children's weight control, these appear best targeted through improving dietary practices and overall parental supervision.

For physical activity, there are also signs that interventions should be at the family rather than the child level, encouraging parents and children to share a similar active lifestyle with a close parent-child relationship and structured behaviour management. Increasing mothers' awareness of desirable levels of physical activity for their children may also have a positive effect on parental support for the child.

Better access to places where children can be physically active, including attractive green spaces, may increase activity levels and reduce sedentary behaviour. The "child-friendly" aspects of the neighbourhood associated with a lower level of child obesity require further investigation in order to understand what is most important here.

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## 8.1 Descriptions of measures used

This section provides a brief description of measures used as predictors, where these were derived from more than one measure supplied by ScotGen in the original data sets for sweeps 1 to 6 of the GUS birth cohort.

### 8.1.1 *Child characteristics*

Birthweight reported by mothers at sweep 1 was standardised for gender, gestational age and parity using tables recently published for Scottish infants (Bonellie et al. 2008). Gestational age was based on mother's reports at sweep 1.

### 8.1.2 *Maternal characteristics*

**Mother's mental and physical health** were based on the SF12 measure of mother's physical and mental health at sweeps 1, 3 and 5. Mean scores were calculated for physical and for mental health over these three sweeps, and scores were divided into tertiles (poor, medium, good health).

### 8.1.3 *Family characteristics*

**Household income:** the average quintile of equivalised household income across the first five sweeps of data collection was calculated from quintiles derived at each sweep (range 1 to 5). Mean scores were then divided once more into quintiles.

**Lone parent** indicated whether the child's biological father did not reside in the household at one or more of sweeps 1 to 6.

### 8.1.4 *Parenting*

**Frequency of sweet and crisp consumption** at sweep 2 was recorded using two questions:

How often does [childname] eat sweets or chocolates? How often does [childname] eat crisps or other savoury snacks? Answers were recorded on a 9-point scale:

- 1 6 or more times a day
- 2 4 or 5 times a day
- 3 2 or 3 times a day
- 4 Once a day
- 5 5 or 6 times a week
- 6 2 to 4 times a week

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- 7 Once a week
- 8 1 to 3 times per month
- 9 Less often or never

Initial exploration did not show differences in children's overweight or obesity with responses less than 5 or 6 times a week, for either type of snack. A combined measure was derived from both items, indicating whether the child had sweets and crisps more than once a week, either sweets OR crisps more than once a week, or neither more than once a week.

**Room where child eats main meal** was based on questions asked at sweeps 2 and 5. Responses were divided into those where the child ate a main meal in the kitchen, dining room or combined living/dining room at both of these sweeps, those where these rooms were used at one of the sweeps, and those where the child did not eat in a room designed for food consumption at either sweep.

**Warmth of mother-child relationship** was measured at sweep 5 using seven items from the Pianta scale (Pianta 1992) (reliability acceptable, Cronbach alpha=0.67). Each item was scored as 1 definitely does not apply, 2 not really, 3 neutral, 4 applies sometimes, or 5 definitely applies. "Can't say" responses were considered as missing. Scores were summed for parents who had completed all warmth items. A high number of parents scored the maximum of 35, and so parents in the lowest tertile (7-33) were contrasted with the remainder (medium/high warmth).

**Joint activities** (carried out by mother and child together) were measured at sweeps 2, 3 and 4. A count of the number of activities that the mother had carried out with the child in the past week was made for each of sweeps 2-4 (from a list of six: books/stories, played outdoors, painting or drawing, nursery rhymes or songs, letters or shape recognition, used a computer or games console). Mean scores were computed and divided into tertiles: low (0 to 3 activities), medium (4 activities) and high (5 or 6 activities).

**Parental supervision** was measured at age 4 using an abbreviated version of the Parent Supervision Attributes Profile Questionnaire (Morrongiello and Corbett 2006). Mothers were asked for their agreement with statements covering protectiveness ("I feel very protective of my child", "I think of all the dangerous things that could happen", "I keep my child from playing rough games or doing things where he/she might get hurt") and supervision while the child plays outdoors ("I can trust my child to play by (him/herself) without constant supervision", "I stay close enough to my child so that I can get to him/her quickly", "I make sure I know where my child is and what he/she is doing") Answers were coded on a 5-point scale from 1=strongly agree to 5=strongly disagree. Item 4 was reverse-coded, and a mean score of the six items (Cronbach's alpha=0.67, indicating acceptable reliability) was computed and divided into tertiles of low, medium and high parental supervision.

**Rules and routines** were measured at sweeps 2 and 5. A count of number of "rules" or routines was derived from the following: 'always' responses to question on regular meals at sweep 2, a question on regular bedtime at sweep 5 and four questions at sweep 5 on whether child had to tidy up toys, brush teeth, stay in room and turn off TV or music in room

(using 4-point scale (always/usually/sometimes/never or almost never). The number of rules was banded into low (0-3 rules), medium (4-5 rules) or high (all 6 rules).

**Home chaos** was measured sweep 5. This was an abbreviated version of the confusion, hubbub, and order scale (Coldwell et al. 2006), devised as a measure of household disorganisation. A number studies suggest that household disorganisation may impair effective parenting (Coldwell et al. 2006; Valiente et al. 2007; Deater-Deckard et al. 2009; Mokrova et al. 2010). Mothers were asked for their agreement with four statements. This was measured from 5-point scales of agreement with four items (Cronbach alpha=0.63, indicating acceptable reliability): “It’s really disorganised in our home”, “You can’t hear yourself think in our home”, “The atmosphere in our home is calm” and “First thing in the day, we have a regular routine at home”. The first two items were reverse-coded. Mean scores were divided into tertiles, indicating low, medium and high levels of chaos.

### 8.1.5 Neighbourhood characteristics

**Child-friendliness** was based on mothers’ level of agreement with six statements at sweep 3: “People around here look out for each other’s children”, “Most people around here can be trusted with children”, “People around here hold shop doors open for parents with pushchairs”, “Bringing up children well is a priority for people in this area” and “This is a good area to bring children up in”. Answers were recorded on a 5-point scale from “strongly agree” to “strongly disagree”. Reliability was good (Cronbach alpha 0.80). Mean scores were used.

**Neighbourhood safety** was measured from mothers’ level of agreement at sweep 3 with two statements: “I feel safe when I am out alone in this neighbourhood during the day” and “I feel safe when I am out alone in this neighbourhood after dark” (responses were on a 5-point scale from “strongly agree” to “strongly disagree”). Average scores were calculated, and divided into those above and below the mean (high versus low perceived safety).

**Antisocial behaviour** was a score of the number of different types of antisocial behaviour occurring in the neighbourhood in the past year, reported by mothers at age 6. Behaviours were prompted using a showcard, and covered:

Noisy neighbours or regular loud parties

Vandalism, graffiti or other deliberate damage to property

Rubbish or litter lying around

Neighbour disputes

Groups or individuals intimidating or harassing others

Drug misuse or dealing

Rowdy behaviour, e.g. drunkenness, hooliganism or loutish behaviour

Abandoned or burnt-out vehicles

Responses were coded into 0, 1, 2, 3 or 4 or more such behaviours.



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