Social gradients in child health and development in relation to income inequality

Who benefits from greater income equality?

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Abstract

There is considerable evidence that health and development are better, on average, in countries with greater income equality. However, much of the research has focussed on average health and wellbeing; it is less clear how this benefit is distributed across society – do people from advantaged and disadvantaged socioeconomic backgrounds benefit equally? Further, there has been little research on the relationship between income inequality and child health.

This thesis aimed *to explore how the social gradient in child health and development varies in relation to income inequality in high income countries.*

I used two approaches to answer the question: Does everyone do better in more equal countries? I conducted a critical review of previous literature comparing social gradients in health and wellbeing. I also conducted original analysis using a comparative cohort study. I compared social gradients in health and development among children aged 4-6, using 7 cohort studies from 6 countries (US, UK, Australia, Canada, Netherlands, Sweden). I reviewed approaches to comparing data between studies and across countries, and harmonised the samples and variables to facilitate comparisons.

The studies in the critical review varied considerably, but there was substantial evidence that health and wellbeing are better for everyone in more equal countries (with the most disadvantaged benefitting the most). In the comparative cohort analysis, there was some evidence that social gradients are steeper in more equal countries (inequalities are greater), and some evidence that everyone does better. However, there were many inconsistencies and comparisons were challenging due to measurement differences between the cohorts.

The observation that social gradients are shallower in some countries than others shows that such inequalities can be prevented. There is growing evidence that people from all social backgrounds would benefit if countries had greater income equality.

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Chapter 1: Introduction

This chapter provides an introduction to the thesis. It starts with background information and a justification for studying social gradients in child health and development in relation to income inequality. I then outline the aim and objectives and research questions for the thesis. I also provide an outline of the structure of the thesis, explaining how each chapter contributes to the aim and objectives.

1.1. Background and justification

Why study the social gradient in health in relation to income inequality?

Income inequality is detrimental to population health

Comparing high income countries with different levels of income inequality, there is considerable evidence that health and development are better, on average, in more equal countries. This pattern is evident across a wide range of health and social outcomes. On average, populations in more equal countries have higher life expectancies, lower teenage pregnancy rates, lower infant mortality, better child wellbeing, lower crime rates and better educational achievement, for example (Pickett and Wilkinson, 2007, Wilkinson and Pickett, 2009b, Gold et al., 2002, Macinko et al., 2004, Mayer and Sarin, 2005).

However, much of the research has focussed on average health and wellbeing in the population. It is less clear how this benefit is distributed across society. Does everyone do better in more equal countries?

Socioeconomic circumstances are a key determinant of individual health

Within countries, there is social gradient in health: each incremental improvement in socioeconomic circumstances brings an associated gain in health. This pattern is evident, no matter how socioeconomic position is measured: health and wellbeing improve with increases in income, education, job status or neighbourhood conditions. Gradients exist for a wide range of outcomes, including life expectancy, mental health, child development and educational achievement (Marmot, 2010).

It is uncertain how income inequality affects the health of people in different socioeconomic circumstances

It is not clear how the social gradient in health varies in relation to the level of income inequality. In particular:

- How does the slope of the social gradient vary in relation to income inequality? Is it steeper in more unequal countries?
- How does the level of the social gradient vary in relation to income inequality?
- Comparing both slope and level of the gradient, does everyone do better in more equal countries?

There is some evidence that the benefits of greater equality are widespread across the social gradient. These studies fall in to two key categories:

First, some studies have compared the level of health/ill health at different points on the social hierarchy between countries with different levels of income inequality. For example, infant mortality rates are lower across all social classes in (more equal) Sweden compared with (less equal) England and Wales (Leon et al., 1992). However, few studies have specifically analysed the role of income inequality in relation to the social gradient of health and development.

Second, some studies have specifically analysed how income inequality at the national/regional level interacts with individuals' socioeconomic position in relation to health or wellbeing. These studies have employed multilevel modelling to analyse the interaction between the contextual effects of income inequality and the compositional effects of individual socioeconomic position. For example, one study used this approach to study life satisfaction among adolescents, concluding that socioeconomic inequalities in life satisfaction among young people within countries were independently related to both national income and income inequality (Levin et al., 2010). A number of studies have investigated the independent and interactive effects of individual income and state-level inequality on health using multi-level modelling (e.g. (Subramanian et al., 2001, Lochner et al., 2001).

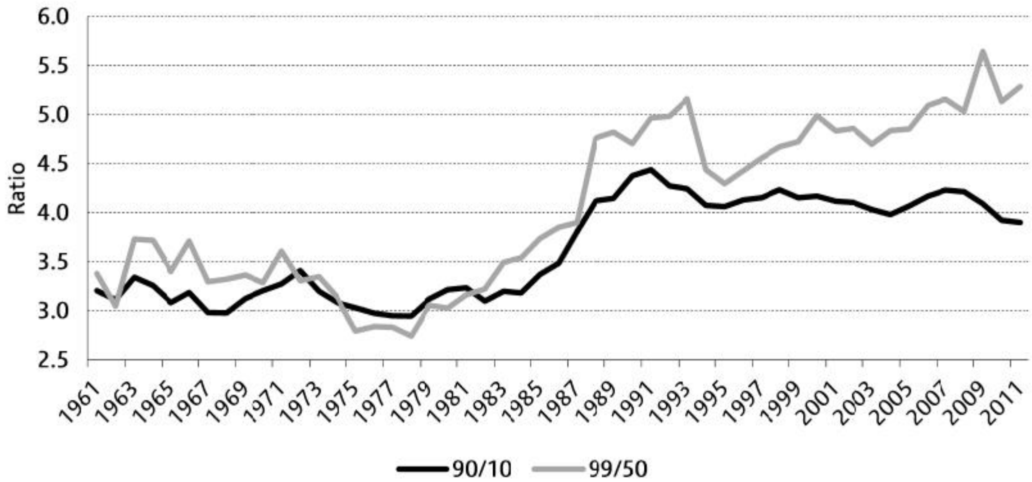
However, the evidence is very limited and is not conclusive. The need for further evidence on health of people in different circumstances, in relation to income inequality, has recently been highlighted. For example, in a recent report on the relationship between income inequality and health, Rowlingson reviewed evidence that inequality is harmful to everyone in society, concluding that "more analysis… perhaps comparing different income groups (including quintiles or deciles) in a wider range of countries and on a wider range of health and social problems, would be useful" (Rowlingson, 2011, page 34).

There is therefore a need to explore how the social gradient in health in countries varies in relation to income inequality.

Understanding social gradients in relation to income inequality has important policy implications

Income inequality has been rising in most high income countries since the 1980s. As a result, the richest 10% within each country now earn on average 9 times the amount earned by those in the bottom 10% (OECD, 2011a). In the UK, income inequality rose sharply in the 1980s. Since 1990, the pattern is more complex, depending on the measure of income inequality used. However, there has been an increase in top incomes relative to the rest of society (Figure 1-1 shows the how the ratio between the 99th percentile and median income has grown over time). It is therefore important to understand the health and wellbeing implications of these social changes.

Figure 1-1: Rising income inequality in the UK, 1979-2011



Source: (Cribb et al., 2013)

Gaining a more nuanced understanding of how different socioeconomic groups are affected by income inequality has important policy implications. Understanding who benefits from greater equality and the extent of the benefit could influence the priority of income inequality in the policy arena. It would also provide information to inform policy responses.

Why study child health and development?

Inequality in health and wellbeing has origins in early childhood

The foundations of adult health and wellbeing are laid in childhood (Irwin et al., 2007). Inequalities in health and development during childhood have long-term implications throughout people's lives, in terms of their heath, social and economic trajectories. Early childhood has been identified as a critical period in terms of policy to reduce socioeconomic inequalities throughout the lifecourse (Marmot, 2010).

If greater inequality damages the lifelong trajectory of a child's health into adulthood, and if this applies to children from the bottom to the top of the social gradient, then the policy implications are profound.

Child health/development is a useful case study

Finally, child health and development provides a useful case study for analysis. It is not possible to study all health/wellbeing outcomes at all ages, so is useful to narrow analysis down to childhood. There have been very few studies comparing the social gradient in more and less equal societies that have focussed on children's health (including physical health, socio-emotional/behavioural and cognitive development).

It is useful to study inequalities in child health, in terms of interpretation of findings. There have been three dominant explanations for social gradients in adult health and the relationship between income inequality and health. Firstly, there is considerable evidence that factors associated with lower socioeconomic position cause poor health. Secondly, the relationship could be due to social selection (reverse causality), i.e. people with poor health tend to do worse and fall down the socioeconomic hierarchy, however there is limited evidence for this. Thirdly, an external factor could affect both health and socioeconomic position.

Arguments about reverse causality are less likely to apply for children. Severe childhood illness may have serious economic consequences for households. However, cognitive development, height and obesity, for example, are unlikely to push the family down the socioeconomic heirarchy. So societies are unlikely to develop greater income inequality as a consequence of health and social selection (downward income drift) among children. Therefore studying child health is particularly helpful in understanding the relationships between income inequality and health and social problems.

Why focus on high income countries?

The relationship between income inequality and health has been found to be strongest and most consistent among high income countries. Above a certain level of national income, increases in income per capita bear little relation to health, and a much closer association is observed between the distribution of incomes in the country and health outcomes (Wilkinson and Pickett, 2009b). Most of the evidence on the relationship between income inequality and health also stems from high income countries. I have therefore chosen to focus on the group of countries classified as high income by the World Bank.

Summary of research problem

We know that child health and development are better, on average, in more equal countries. We also know that there is a social gradient in child health and development within countries. It is not clear, however, how the social gradient varies in relation to income inequality: do children growing up in all socioeconomic circumstances do better in more equal countries?

1.2. Aim and objectives

Aim

To explore how the social gradient in child health and development varies in relation to income inequality in high income countries

Objectives

1) To review approaches to measuring and comparing the social gradient in child health and development
2) To review studies that have compared the social gradient in health and wellbeing between high income societies with different levels of income inequality
3) To analyse and compare social gradients in child health and development using data from high income countries with different levels of income inequality
4) To summarise and discuss the evidence on social gradients in child health and development in relation to income inequality

Specific research questions

The aim and objectives will answer the following specific research questions, concerning features of the social gradient in health and development:

- How does the *slope* of the social gradient vary in relation to income inequality? (Is the gradient steeper in more unequal countries?)
- How does the *level* of the social gradient vary in relation to income inequality? (Is health worse overall in more unequal countries?)
- *Does everyone do better in more equal countries*? (comparing both the slope and level of the gradient)

1.3. Structure of thesis

The thesis is structured into 3 parts, with 10 chapters. A summary of how each of the chapters contribute to achievement of the overall objectives is provided in Table 1-1.

Part I: Background and literature review

This part contains three chapters.

Chapter 2: Socioeconomic position, income inequality and child health and development

This chapter provides a summary of evidence on the social gradient in child health and development, and the relationship between income inequality and health. It provides an overview of the evidence on patterns and associations, and considers the theories and mechanisms that have been proposed in the literature. This chapter provides a background to the other chapters in the thesis, and, in particular, provides background information for the discussion in chapter 9.

Chapter 3: Approaches to measuring and comparing socioeconomic inequalities in child health/development and income inequality

This chapter provides an overview of the approaches towards measurement of socioeconomic position (with a focus on children), health inequality/the social gradient, income inequality and child health and development. This information informs interpretation of studies in the critical review (chapter 4) and informs the development of methods for the comparative cohort analysis (chapters 5-8). The review contributes to objective 1.

Chapter 4: Critical review of studies that have compared the social gradient in health and wellbeing in more and less equal societies

This chapter reviews studies that have compared the social gradient in health and wellbeing (for adults and children) between societies with different levels of income inequality. Where the role of income inequality has not been analysed in the studies, I conduct further analysis to investigate the relationship with income inequality. This chapter achieves objective 2.

PART II: Comparative cohort analysis

This part contains 4 chapters. These chapters together report the comparative analysis of social gradients in child health and development using cohort studies from high income countries, in order to achieve objective 3.

Chapter 5: Comparative cohort analysis - Background and methods

This chapter provides a short review of methods for harmonising data from cohort datasets. It also provides background information on the cohort datasets included in the study. Finally, it provides an overview of the methods I used to harmonise the cohort datasets and analyse and compare social gradients in child health and development.

Chapter 6: Comparative cohort analysis - Descriptive statistics

This chapter provides descriptive statistics for the included cohort studies. It provides an overview of the samples included (and numbers excluded). It includes descriptive statistics on household income and parental education for children in each cohort. Descriptive statistics are also provided for each child health and development outcome.

Chapter 7: Comparative cohort analysis - Social gradients in child health and development in relation to income inequality

This chapter presents and compares social gradients in child health and development in relation to national level income inequality for each cohort dataset. Both unadjusted gradients and analyses adjusting for child age and sex are presented for household income, parental income and all child health and development outcomes.

Chapter 8: Comparative cohort analysis - Discussion

This chapter discusses the findings from the comparative cohort analysis. It addresses two key questions. First: to what extent can we be certain that findings represent actual population differences (rather than other differences, e.g. measurement variations between cohorts)? Second, what role does income inequality play in explaining differences in social gradients in child health and development between countries (with consideration of other contextual differences)?

PART III: Discussion and conclusion

This part contains 2 chapters:

Chapter 9: Discussion of the evidence on social gradients in relation to income inequality

This chapter brings together the evidence on how social gradients in child health vary in relation to income inequality from the critical review (chapter 4) and the comparative cohort analysis (chapters 5-8). I then discuss the findings of the thesis, developing implications for theory and policy. This chapter achieves objective 4.

Chapter 10: Conclusion

This chapter presents the conclusions from the thesis.

Appendices

The appendices include further information on topics discussed in the chapters and further tables of statistics for the comparative cohort analysis.

Table 1-1: Summary of objectives addressed in thesis chapters

Objectives	Chapters addressing objective
1) To review approaches to measuring and comparing the social gradient in child health and development	Chapters 3 and 5
2) To review studies that have compared the social gradient in health and wellbeing between high income countries with different levels of income inequality	Chapter 4
3) To analyse and compare social gradients in child health and development using data from high income countries with different levels of income inequality	Chapters 5-8
4) To summarise and discuss the evidence on social gradients in child health and development in relation to income inequality	Chapter 9

1.4. Presentation of findings

Wherever possible, findings on social gradients in child health are presented using graphs (additional tables and figures are provided in the Appendices). Graphs have been colour coded in relation to income inequality to facilitate visual comparisons of gradients. All gradients are presented in shades of blue, with lighter shades of blue representing more equal countries and darker blue representing more unequal countries.

PART I: BACKGROUND AND LITERATURE REVIEW

Chapter 2: Socioeconomic position, income inequality, and child health and development

This chapter summarises the evidence on the relationships between socioeconomic position, income inequality and health, with a focus on child health and development. I first review the evidence on the relationship between socioeconomic position and child health and development, with an overview of the different models that have been put forward to explain the relationship. I then summarise the evidence on the relationship between income inequality and health at a national level, followed by an overview of explanations and mechanisms that have been put forward. I give an overview of the role of the welfare state, in relation to income inequality, socioeconomic position and health. Finally, I develop a conceptual framework to summarise the overlapping layers of influence on child health and development.

2.1. Introduction

Many countries are becoming more unequal. Since the mid-1980s the level of income inequality has grown in two thirds of OECD countries, including marked increases in inequality in the UK and the US (OECD, 2008).

There has been increasing recognition of the importance of socioeconomic inequality and other broad social conditions are key determinants for population health, in relation to the relatively small role played by health care systems (Evans et al., 1994). The unequal distribution of socioeconomic resources within countries affects population health and wellbeing in two ways. First, there are social gradients in health and wellbeing within countries, such that each incremental level of socioeconomic advantage confers health and wellbeing benefits at the individual level. Second health and wellbeing tend to be worse, at a population level, in countries that are more unequal.

This chapter summarises the evidence on the social gradient in children's health and development, and outlines the models developed to explain these links. I then give an overview of the relationship between income inequality and child health and wellbeing and our understanding of the mechanisms. I also give an overview of the role of the welfare state in relation to income inequality, socioeconomic position and health. Understanding the types of welfare states and their components helps us to contextualise understanding of socioeconomic position, income inequality and health. Throughout the chapter, I discuss the evidence with a focus on children's health and development. I have defined health and development broadly to include physical health, socio-emotional/behavioural and cognitive development outcomes.

2.2. Social gradients in health and development

A summary of the evidence

The health gap between the advantaged and disadvantaged in society has long been recognised. Victorian public health reformers in the UK noted the burden of ill-health among the poor and those working in particular occupations (Whitehead, 2000) and campaigned for social reform and public health interventions. Emphasis was placed on reducing the gap between the rich and the poor. More recently, attention has shifted to the gradient in health across the whole socioeconomic spectrum. The effects of social and economic factors on health are not confined to those living in poverty; rather, every incremental increase in socioeconomic position confers health and wellbeing advantages (Adler et al., 1994). There is firm evidence that health and wellbeing are incrementally worse among the more disadvantaged in society, measured in different ways. Yet the extent and causes of inequalities remain debated, due to methodological difficulties (discussed further in chapter 3) and political implications.

Socioeconomic position can be defined at the individual or household level, in terms of income, educational achievement or occupation, or at the area level, for example neighbourhood deprivation (discussed further in chapter 3). No matter how we choose to measure socioeconomic disadvantage, the gradient is still apparent. This pattern also exists in different parts of the world, including low income countries (Victora et al., 2003).

The gradient is evident across different child health, socio-emotional/behavioural and cognitive development outcomes (Bradley and Corwyn, 2002). The pattern is also present at different stages of the lifecourse (Chen et al., 2006, Bradley and Corwyn, 2002).

Before birth, there is a social gradient in foetal development, including intrauterine growth restriction (Kramer et al., 2000). Women with lower socioeconomic position are more likely to have adverse birth outcomes, including low birth weight and preterm birth (Blumenshine et al., 2010). In Britain, babies in the most deprived tenth of areas are twice as likely to be born very preterm (between 22 and 32 weeks' gestation) than those in the least deprived tenth (Smith et al., 2007). There is also a steep social gradient birth weight (Howe et al., 2010) and in infant mortality (Leon et al., 1992).

Early child development has a steep social gradient. Child height is associated with socioeconomic circumstances (Howe et al., 2010). Gradients in unintentional injuries are particularly steep: disadvantaged children are more likely to have accidents at home or on the road (Laflamme et al., 2010). Considerable differences in cognitive development between children from wealthier and poorer backgrounds are already evident at age 3 and widen further by the time children start school at age 5 in the UK (Dearden et al., 2011).

Gradients persist throughout childhood, into adolescence. Young people from more disadvantaged backgrounds are more likely to engage in detrimental health behaviours, including smoking, poorer diet and less physical activity (Hanson and Chen, 2007). When asked to rate their health or life satisfaction, adolescents at higher socioeconomic positions give higher ratings (Levin et al., 2010, Starfield et al., 2002).

However, evidence on the social gradient is not consistent across health and development outcome and age groups. There is conflicting evidence on how and why the gradient changes with age. Some researchers have demonstrated that gradients flatten out during adolescence, developing a theory of 'equalisation in youth' (West, 1997). Yet other analyses have found persistent gradients through this age period (Starfield et al., 2002). Overall, patterns seem to differ by outcome. For some outcomes, gradients are steeper at younger ages and level out in adolescence, for example accidents (Laflamme et al., 2010). On the other hand, for some outcomes there is evidence that gradients may become steeper as children get older, for example gradients in respiratory illnesses appear during adolescence (Chen et al., 2006). A number of reasons have been put forward for these gradients, which are discussed below.

Inequalities in health and development during childhood have lifelong effects into adulthood (Hertzman and Wiens, 1996). The pathways through which this occurs are discussed in the following section. There is growing evidence of how the long-term effects can be modified through intervention (summarised in chapter 9).

How does socioeconomic position influence health?

There is clear and consistent evidence that people's position in the socioeconomic hierarchy has a strong influence on their health, yet the pathways through which socioeconomic circumstances affect health are complex and remain disputed. In this section I review the main models of pathways: material, behavioural and psychosocial pathways, and lifecourse explanations. I consider the relative importance of the different models in explaining gradients, and why these may change with age.

I give a general overview, with a particular focus on child health and development. For each model, it is important to consider both the mechanisms through which child health is affected directly and the indirect mechanisms through parents, other relatives, peers and the wider community. We should also bear in mind that child socioeconomic position is not static – rather, it may change over time.

Material and neo-material pathways

It has long been recognised that people who lack the infrastructure or material means necessary for good health have higher rates of illness. Indeed public health infrastructure, as well as material living conditions played a key role in the late eighteenth century decline in mortality in Britain (Szreter, 2002). However, following the epidemiological transition, the relevance of material conditions for the most prevalent diseases today is less certain.

The material model asserts that lacking finances and resources in absolute terms affects health. A range of resources are needed for children to develop, including adequate housing and nutrition. Housing quality affects health, playing a causal role in conditions such as asthma and lead poisoning (Bashir, 2002). In high income countries (and increasingly in low and middle income countries), inadequate nutrition includes both insufficient and excess nutrition in parallel.

The neo-material model recognises that causes of disease have changed, and incorporates the effects of infrastructure and services, as well as individual material means, in creating the differential accumulation of exposures and experiences that affect health (Lynch et al., 2000). Differential access to and quality of services, including health care and education clearly affects children's health and development. However significant social gradients remain despite the universal coverage of the NHS in the UK.

Whilst material and neo-material models explain why people living in absolute poverty are at greater risk of poor health, they are less useful for explaining the social gradient. Few people live in abject poverty in the UK today; the vast majority of people have adequate housing, consume enough calories and have access to education and health services. Yet we do not only see the few living in absolute poverty experiencing worse health and development, rather people experience worse outcomes at every step down the social ladder. An absolute lack of resources or services therefore is unlikely, on its own, to explain the gradient we see in child health and development.

Material circumstances may affect health directly or indirectly through shaping health behaviours such as smoking, nutrition and exercise. The links between material factors and health behaviours are clear in some cases (e.g. we need adequate income to be able to eat healthily), although psychosocial factors such as stress may also be important (Wilkinson and Pickett, 2006). There are links between the material/neo-material model, indeed Lynch and colleagues argue that the psychosocial effects of inequality cannot be understood without reference to the unequal material conditions in which people live their lives.

Psychosocial pathways

There has been growing emphasis on psychosocial influences on health. Psychological mechanisms have been recognised for several decades, e.g. (Evans et al., 1994), and biological evidence for these pathways is now growing. According to psychosocial theories, it is a person's position in the social hierarchy relative to others that is important to health (rather that their absolute level of resources). Income, education or occupation are markers of prestige and status, rather than material resources themselves. In other words, there is a focus on how people feel rather than what they have. For example, circumstances such as social isolation or lack of control, which make people feel stressed, can impact on their mental and physical health.

The observation of social gradients of health, even among people who do not seem to have an absolute lack of material resources, first led to the suggestion that psychosocial mechanisms affect health. The Whitehall studies of health among civil servants in London added evidence that there was a gradient in coronary heart disease even among people who worked in an office environment (Marmot et al., 1978). Participants did not seem to lack the material means necessary for health or to be exposed to physical occupational hazards. Furthermore, employment grade explained more of the differences in health than conventional risk factors and risk behaviours, such as smoking. Marmot and colleagues therefore suggested that stress and social status played a role. In a follow-up study, low control at work was found to explain a large part of the gradient in coronary heart disease (Marmot et al., 1997).

Further, a number of studies have shown that where people stand in the social hierarchy relative to others, e.g. income rank, is more important that their absolute income for their mental health and life satisfaction (Wood et al., 2012, Boyce et al., 2010). A recent study that I coauthored showed that relative socioeconomic position is also important for adolescent health: relative measures of affluence (rank and Yitzhaki index within the region or school) related more closely to psychosomatic symptoms in adolescents than absolute material affluence (Elgar et al., 2013).

It is useful to break down the psychosocial mechanisms into overlapping layers of influence on health. At the centre, we can look at the individual and the ways in which psychological factors have a biological influence on the body. We can then look back to the ways that the social environment has influenced these psychological factors, including the proximate social environment (home, school, work and community) and the national context.

These factors may have a direct impact on children's health, or may have an indirect impact through parental health and behaviour. Children at different socioeconomic positions have differential experiences of these psychosocial factors, with differential impacts on health and development. For example children whose mothers were stressed during pregnancy are more likely to develop emotional or cognitive problems (Talge et al., 2007).

How do psychological factors have a physiological effect on health and wellbeing?

Our understanding of the physiological processes through which stress and other psychological factors affect health focuses on neuroendocrine pathways, wound healing and immune response. Although I summarise the evidence on each of these separately below, it is important to note that the biological pathways are complex and interact.

Neuroendocrine pathways evolved to protect the body against short-term, physical threats in the past – the 'fight or flight' response. Increased heart rate, the release of energy and other responses helped the body to rapidly fight off the impending threat, after which it returned to normal with little effect on health. In today's environment, people rarely experience short-term physical threats. However, psychological stresses are common and often chronic, for example financial worries, social isolation, and even sitting in traffic jams (Bartley, 2004). Psychologically stressful conditions repeatedly trigger the body's 'fight or flight' response, which, as short-term physical responses are rarely required, can have a damaging effect on the body in the long term. Exposure to chronic stressful conditions can divert energy from normal body activities and affect the cardiovascular and immune systems, in turn making people more susceptible to infections and coronary heart disease. These pathways and problems are summarised in Table 2-1.

There is evidence of a social gradient in these pathways and hormones. For example, people with lower socioeconomic position have higher levels of cortisol and fibrinogen and higher blood pressures (reviewed in Bartley, 2004). However, cortisol levels and response patterns are complex and difficult to research. The evidence on social gradients remains inconsistent and further research is needed.

There is growing evidence of these patterns among children. Socioeconomic circumstances can have long-term effects on children through psychological and neurological pathways, for example through socioeconomic position and trauma can affect development of the endocrine system, including corticosterone release (Keating and Hertzman, 1999). In a study in Canada, for example, morning salivary cortisol levels were found to be higher among young children from low socioeconomic backgrounds, although the inequality levelled out among high school age children (Lupien et al., 2001). Evidence from animal models has explored the role of the HPA axis, showing that prenatal stress can affect the functioning of the HPA axis, with long-term effects on offspring development (Talge et al., 2007).

Further evidence of the physiological effects of stress has been provided from studies of wound healing and immune response. Although material living conditions clearly play an important role in socioeconomic differences in exposure to infection, there is increasing understanding of how stress can impair the immune system, increase susceptibility to and severity of infections. These processes may play in important role among children, for whom infection is an important cause of morbidity and mortality.

Table 2-1: Neuroendocrine pathways and chronic stress

Neuroendocrine pathway	Physiological role	Problems with chronic exposure to stress
Sympatho-adrenal circuit	• Regulates the release of noradrenaline and adrenaline – the 'fight or flight' response • Arouses the mind, mobilises energy and suppresses body functions not required for immediate survival • Accelerates heartbeat, increases blood pressure and body temperature, increases metabolic rate in response to threats • Triggers release of fibrinogen, which helps blood to clot • In evolutionary past was an important response to fear or anger; the pathway was switched off when the threat had passed	• Chronic exposure to stressful situations can lead to raised blood pressure, • Blood clotting in the absence of injury may lead to a greater chance of cardiovascular disease
Hypothalamic-pituitary-adrenocortical (HPA) circuit	• Releases cortisol and glucocorticoids into the bloodstream • Feedback mechanisms adjust the amount of cortisol circulating in the bloodstream • Has metabolic effects - releases sugars and fats from storage to provide energy for the body. These can be burned off if the stressful situation creates violent activity • Has psychological effects – glucocorticoids promote vigilance	• Many chronic psychological stress situations do not require sugars and fats for energy. If released sugars and fats are not burned off they can lead to the build-up of atheroma in arteries, putting the body at increased risk of cardiovascular disease • Long-term high levels of cortisol may have long-term psychological effects, e.g. depression, paranoia • Glucocorticoids may divert body from other tasks e.g. fighting infection, repairing damage

Source: (Brunner and Marmot, 2006) (Bartley, 2004)

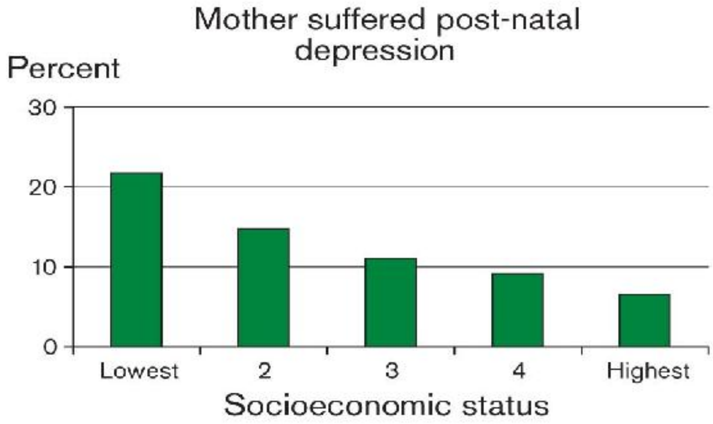
How does the social environment affect psychological factors?

We can look at the proximate social environment in the household or family, including the quality of family relationships, and parental separation. The school, work or community environment also plays a role. These all overlap, for example the work environment may lead to parental stress, which affects children in the home environment.

Much research has been conducted on the role of stress. Stress is often perceived to be a condition that affects people at the top of the social hierarchy in high-powered, high responsibility jobs, such as bank managers, solicitors. However, studies have shown that people who have a lower social status often do monotonous work, have inadequate social support and financial worries and experience greater on-going psychological stress (Brunner and Marmot, 2006). There has been considerable research on how the work environment affects levels of stress. Numerous studies have demonstrated that a high level of demand with little control at work, or high effort and low reward, are important risk factors for poor health (Karasek et al., 1988, Marmot et al., 1997). The effects of status within groups on stress have been studied among non-human primates. This has enabled researchers to experimentally alter status hierarchies, showing that low status and a drop in status are associated with higher levels of the stress hormone cortisol (reviewed in Wilkinson and Pickett, 2009a).

There has been less research on the psychosocial effects of the home and school environments for children. It is unclear how children experience stress directly and the health effects of this. But it is easy to understand how parental stress could affect parental behaviours with children, including the level of interaction, and health behaviours, which may in turn influence outcomes such as accidents, socio-emotional or cognitive development. Maternal mental health plays a key role and has a steep social gradient (Figure 2-1), so more disadvantaged children are at greatest risk. Mothers who develop depression are more likely to develop poor health behaviours, show lower interaction and attachment with their children and lower concentration, which in turn can affect child health and development (O'Hara, 2009). Children whose mothers are depressed have poorer cognitive development (Mensah and Kiernan, 2010). They also have poorer social and emotional development and are more vulnerable to developing depression or anxiety themselves (Murray, 2009, Mensah and Kiernan, 2010). There is also evidence of poorer physical health and development, including poorer foetal growth (Hoffman and Hatch, 2000), and lower breastfeeding rates (Chung et al., 2004) among the children of mothers with postpartum depression.

Figure 2-1: The gradient in children having a mother with postnatal depression, by socioeconomic status



Source: (Marmot, 2010)

Children from lower income backgrounds experience higher numbers of stressful negative life events (Chen et al., 2002). This in turn has a physiological toll on the body and puts children at greater risk of ill health. Children may develop personality traits in response to the environment that they grow up in. For example, Chen and colleagues suggest that a child growing up in a dangerous deprived area may be more likely to be mistrustful of others and hostile, which in turn may impact on their health (Chen et al., 2002).

All of this occurs within a national context. At this level, social policies and the level of inequality in society are important (discussed further below).

Behavioural/cultural pathways

That differences in health may result from behavioural and cultural differences between socioeconomic groups has recently been emphasised in the academic and policy arenas. Bartley has defined this as ‘differences in beliefs, norms and values [which] mean that individual members of less advantaged social groups are less likely to drink alcohol moderately, abstain from smoking and take exercise in leisure time” (Bartley, 2004, page 16).

Children and adolescents’ own behaviours may affect their health. There is a well-recognised social gradient in smoking and physical activity, including among adolescents (Hanson and Chen, 2007). Parental behaviours may also play a role – both in influencing child behaviours and directly influencing child health. Bradley and Corwyn reviewed literature on parenting styles, finding that parents with a high socioeconomic position are more likely to expose their children to cognitively stimulating experiences, including reading to their children, engaging them in conversations and taking them to educational or cultural events, with an impact on cognitive development and school achievement (Bradley and Corwyn, 2002).

There is evidence, however, that behaviours only explain a proportion of the social gradient in health. For example, Dowd found that maternal behaviours, including smoking, breastfeeding and vitamin use, did not explain the relationship between socioeconomic position and child health (Dowd, 2007). This indicates that other mechanisms must play a role. Behavioural models are also limited in aiding our understanding of the underlying reasons for people's behaviour – why do people behave as they do? They have neglected understanding of the roles that material and psychosocial issues play in shaping people's behaviour. Furthermore, behaviours are often seen as a choice in the policy arena, raising concerns about fairness of policy responses, especially for children.

Lifecourse approaches

Finally, the lifecourse model has gained popularity over the last 20 years. The lifecourse model does not provide an alternative explanation to the other models; rather, it situates material, behavioural and psychosocial models within a lifecourse framework. Lifecourse approaches recognise how health and social factors at different times in the life course affect health later in life, and even across generations (Kuh et al., 2003).

A number of theoretical models have been developed in to explain these links. These models are theoretical and often portrayed as mutually exclusive; in reality they overlap and aspects from each model are likely to influence health and health inequalities.

First, being exposed to adverse circumstances during ***critical or particularly sensitive periods*** of growth or development can programme the structure or functions of systems in the body and may lead to disease later in life (Kuh et al., 2003). This has also been termed the 'latent effects' model (Hertzman and Wiens, 1996). Model (a) in Figure 2-2 shows how an exposure during a critical period in childhood could affect adult health. In particular, poor foetal growth in utero (marked by low birth weight) has been shown to be associated with coronary heart disease, stroke, diabetes and respiratory disease in adulthood (Barker, 1998). There is a steep social gradient in low birth weight (Marmot, 2010, Spencer and Logan, 2002), indicating that this is an important determinant of adult health inequalities. The first few years of life are a critical period for brain development (Irwin et al., 2007).

Distinctions have been made between critical periods (when exposures have a strong and irreversible effect) and sensitive periods (when exposures have a strong effect, but they may also have effects at other times and the effects may be reversible) for different types of exposures or diseases later in life (Kuh et al., 2003). Furthermore, other exposures later in life may modify the effects of critical or sensitive periods, for example evidence that low birthweight babies who are then obese in adulthood have greatest risk of coronary heart disease (Kuh and Ben-Shlomo, 2004) suggests that obesity later in life modifies the effect of foetal growth on heart disease.

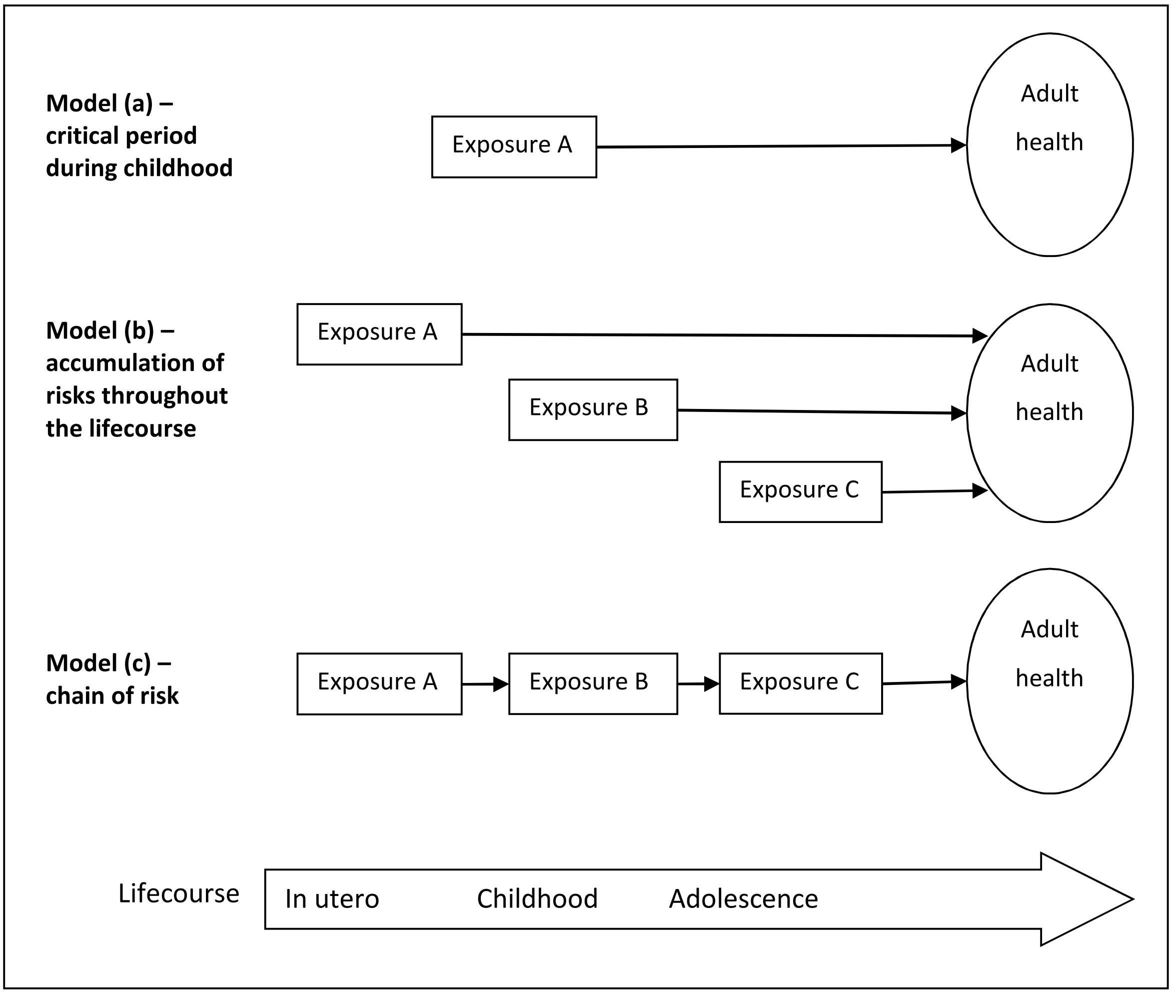
Second, ***accumulation of risks*** or damage may occur (Kuh et al., 2003). Model (b) in Figure 2-2 shows how an exposure can accumulate over the lifecourse to affect adult health. For example, exposure to negative socioeconomic circumstances at multiple stages of life accumulate to increase the risk of coronary heart disease (Galobardes et al., 2008). One study of the association between childhood socioeconomic status and coronary heart disease in adult men found that childhood low socioeconomic status had a modest effect on adult CHD risk. However, men who experienced low socioeconomic position in both childhood and adulthood had the highest risk of CHD, i.e. damage from low socioeconomic status accumulated during the lifecourse (Ramsay et al., 2007).

Negative circumstances in childhood are often clustered; circumstances such as poor nutrition, parental smoking, parental depression or lack of parental interaction with children may have a cumulative effect on risk of developing diseases in adult life.

Finally, an exposure may set off a ***chain of risk or advantage***, in which one exposure leads to another in a chain, which leads to health or disease later in life (Kuh et al., 2003). This has also been termed the 'pathways model' (Hertzman and Wiens, 1996). Model (c) in Figure 2-2 shows how a chain of risk can affect adult health. There may be interaction between the exposures in the chain and other factors, such as individual factors, social resources, behaviour, household resources and environment, wider environment.

Circumstances in childhood may trigger a chain of risk that affects adult health. In particular, adolescence is a key time at which important transitions are made, which may be key links in the chain, e.g. education and work choices (Kuh and Hardy, 2002).

Figure 2-2: Lifecourse models showing how childhood circumstances can affect adult health



Source: Adapted from (Kuh et al., 2003)

Do differences in health cause social selection?

Health could act as a selecting force that pushes people into better or worse socioeconomic circumstances. This 'social selection' model has similarities to natural selection; a person's position in society is as a result of their level of 'fitness' or health. For example, a child with chronic illnesses might achieve a low level of education and, in turn, obtain a low-paid, manual job; conversely, someone who is healthy might perform well in education and work and obtain a higher status and income profession. However, the evidence for such 'direct selection' is limited in high income countries. Lifecourse approaches have allowed children or adults who have illnesses to be followed up to determine whether ill health leads to lower socioeconomic position. There is some evidence that mental illness may lead to social drift into lower socioeconomic groups. However, generally the evidence shows that socioeconomic disadvantage occurs before poor health (Blane et al., 1993).

The theory of 'indirect selection' offers a more complex explanation. This focuses on people's 'potential' for good health. People who have higher intelligence, better coping strategies etc. may be selected into higher socioeconomic groups. However, the picture is likely to be more complex, involving causality in the other direction through the important role that social conditions in children play on the development of skills and qualities such as intelligence and coping.

In terms of child health, it is possible that having a child with a severe illness or disability could push a household into poverty, although this is less likely for less severe conditions, or other indicators such as child height. Further, selection arguments are insufficient to explain the extent of the social gradient (Adler et al., 1994). It is possible that selection may play a larger role in low income countries, where access to care and social support are often less adequate. Many studies have documented how illness and the costs of health care can push households into poverty, often termed the 'medical poverty trap' (Whitehead et al., 2001). Yet even in low income countries, the effects of ill health on socioeconomic status are unlikely to be significant enough to explain the extent of health inequalities.

Summary of the links between SEP and child health and development

We cannot say that one model explains the social gradient in child health and development at all ages and for all outcomes. The models are not mutually exclusive – rather, they influence each other and interact to form a complex web of links between socioeconomic position and health. I have summarised the way the four models link together to shape health and development in Figure 2-5 at the end of this chapter.

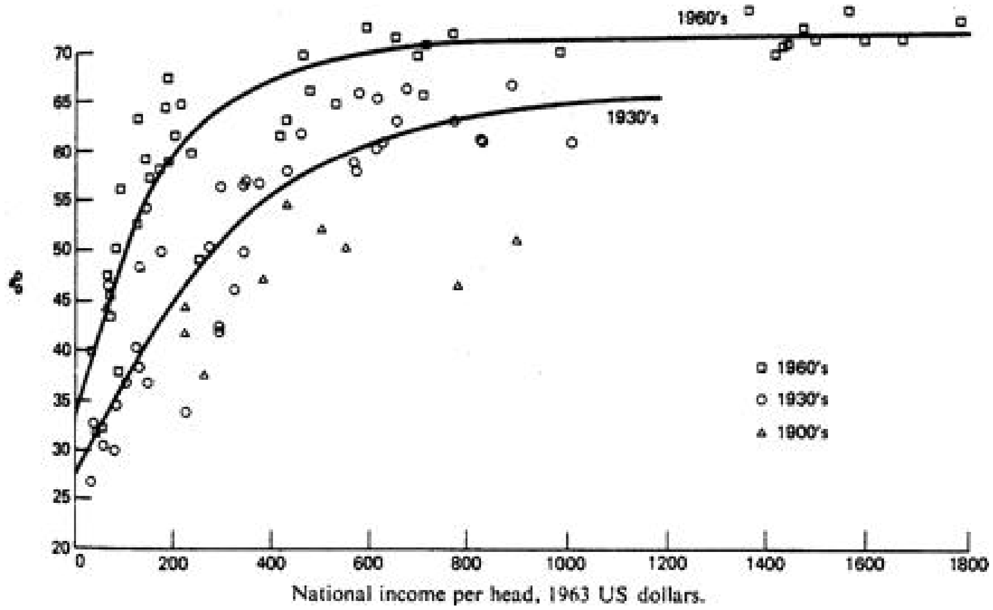
2.3. The relationship between income inequality and health

A summary of the evidence

The suggestion that health tends to be better in more equal countries was first put forward over 25 years ago. Preston (republished 2007) plotted life expectancy against national income between the 1900s and 1960s and fitted curves to the data (Figure 2-3), showing that there are diminishing returns to increases in national income (i.e. there is a steep relationship between national income and life expectancy among lower income countries, but there was less relationship among high income countries). He noted that there had been upward shifts in life expectancy during that time period, but that only a small proportion of this could be explained by increases in national income. Preston proposed that some of the differences in life expectancy could be due to the distribution of income.

Since this influential paper, over 200 studies have analysed the link between income inequality and a wide range of health and social outcomes, including adult and infant mortality, life expectancy, self-rated health and violent crime. The policy implications are considerable; if income inequality is a determinant of population health, policy to improve public health needs to focus upstream on reducing disparities, e.g. through redistribution.

Figure 2-3: The relationship between life expectancy at birth and national income per head for nations in the 1900s, 1930s and 1960s



Source: (Preston, 2007)

Despite this body of evidence, the topic remains controversial. Reviews have interpreted the evidence differently and reached inconsistent conclusions about the association between income inequality and health. Lynch and colleagues concluded that "income inequality is not associated with population health differences – at least not as a general phenomenon – among wealthy nations" (Lynch et al., 2004, page 81). The authors reviewed 98 studies. They classified 20 of the 33 multilevel studies reviewed as providing at least some support for the effects of income inequality on health.

In contrast, in a later review Wilkinson and Pickett concluded that "income distribution is related to health where it serves as a measure of the scale of social class differences in a society" (Wilkinson and Pickett, 2006, page 1778). In their review of 168 analyses, the authors classified over three quarters of the studies as either wholly or partially supportive of the hypothesis that greater income differences are associated with lower standards of population health. A more recent meta-analysis by Kondo and colleagues also concluded that there is a small but significant effect of income inequality on health (Kondo et al., 2009).

Some studies have analysed the relationship between income inequality and child health and development outcomes. Several have found associations between income inequality and infant mortality rates, for example (Macinko et al., 2004, Hales et al., 1999, Mayer and Sarin, 2005), but not post-neonatal mortality (Mayer and Sarin, 2005). However, we should bear in mind that there are problems with comparisons of infant mortality between countries, due to differences in the ways infant deaths are recorded (discussed further in Chapter 3 and Appendix 3). Teenage birth rates have been shown to be sensitive to income inequality (Gold et al., 2002), as have child overweight and wellbeing and educational achievement scores (Pickett and Wilkinson, 2007). The UNICEF index of child wellbeing has also been shown to be related to national levels of income inequality (but not to national income levels) as shown in Figure 2-4 (Pickett and Wilkinson, 2007, Wilkinson and Pickett, 2009b).

How large is the effect of income inequality on health?

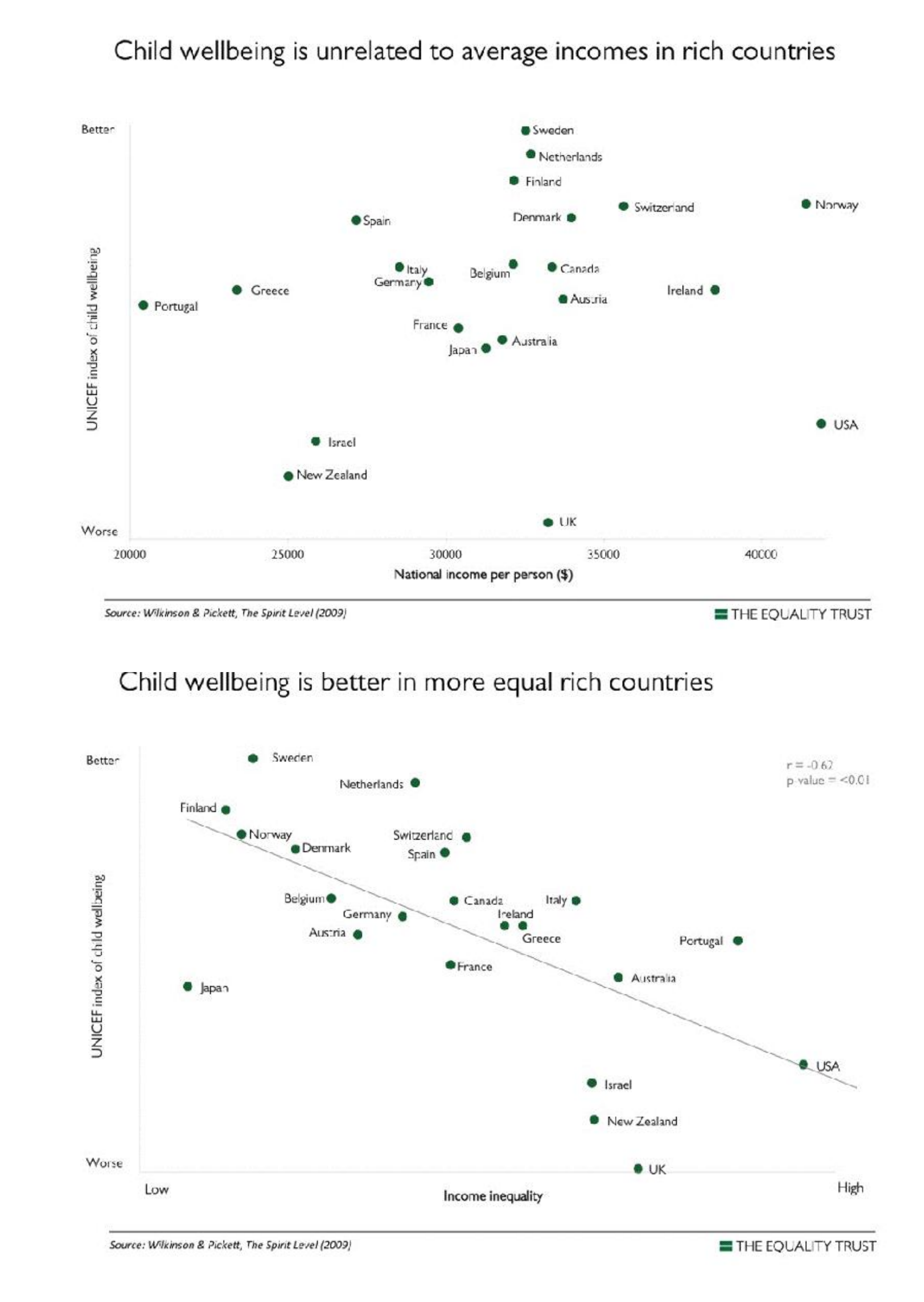
There have been considerable methodological differences between studies, for example in measures of exposure and outcome, whether inequality is measured and compared at national or sub national (e.g. regional) level and analysis techniques used. This makes it difficult to compare the associations found in different studies.

A recent meta-analysis of 28 studies assessing the relationship between income inequality and mortality or self-rated health concluded that income inequality has a "modest adverse effect on health" (Kondo et al., 2009, page 1). The authors pointed out that although the effect was relatively small (meta-regression yielded an increased mortality risk of approximately 8% for each 0.05 unit increase in the Gini coefficient), the population-level effect is potentially large, given that the whole population is exposed.

There are a number of issues that we need to take into account in interpreting these findings. Firstly, of the 28 studies included, only three compared the level of national inequality across countries; the rest compared inequality at sub national level within countries. Income inequality measured at the country level has a larger and more consistent relationship with health (discussed further below) (Wilkinson and Pickett, 2006), therefore the meta-regression may have underestimated between-country effects. Also, few of the included studies included children. It is therefore not possible to disentangle the relationship with child health from adult health.

Kondo and colleagues found some evidence for a threshold effect (Kondo et al., 2009). Among countries with a Gini of 0.3 or higher, the relative risk of mortality associated with increased income inequality was higher. They suggest that there is a more consistent association with health in the most unequal countries.

Figure 2-4: Child wellbeing in relation to national income and income inequality in rich countries



Why have studies drawn different conclusions?

There are considerable differences in the methods used in individual studies and interpretation of findings.

First, **differences in the health and income inequality indicators** used in analyses affect study findings. The health and wellbeing outcomes that are most susceptible to income inequality are the outcomes with a social gradient (Wilkinson and Pickett, 2009a, Wilkinson and Pickett, 2008). I conducted further analysis of this and found that the same was true for child health: indicators of child health/development with a social gradient were more likely to be related to income inequality (Appendix 2). As discussed in chapter 3, there are numerous ways to measure income inequality. Different indicators of inequality put weight on different parts of the income distribution (De Maio, 2007). Therefore the choice of income inequality indicator could affect the size of the relationship - although Kondo and colleagues found that the choice of inequality measure did not explain heterogeneity between studies in their meta-analysis (Kondo et al., 2009).

The **size of area at which inequality is measured** and comparisons are made plays an important role. A greater proportion of studies comparing national level data show a relationship between income inequality and health than those comparing sub-national levels (e.g. regions, census tracts or parishes) (Wilkinson and Pickett, 2006).

There is some **inconsistency between time periods and suggestion of lagged effects** of income inequality. In their review, Wilkinson and Pickett noted that between the late 1980s and 1990s, several studies did not show a relationship with mortality, however, the relationship subsequently re-emerged. The relationship with child health was more consistent (Wilkinson and Pickett, 2006). In their meta-analysis, Kondo and colleagues made a similar observation that the relative risk of mortality associated with increased income inequality was higher in studies using baseline data post-1990 (Kondo et al., 2009).

This time period was marked by widening income inequality. One possible reason for this pattern is that income inequality has a lagged effect on adult mortality, which was not taken into account in studies (Wilkinson and Pickett, 2006, Subramanian and Kawachi, 2004). Kondo and colleagues also found that the relative risk of mortality associated with increased income inequality was higher in studies that had a length of follow up over 7 years (Kondo et al., 2009). However, lag times may be shorter for child health, so more closely related to current levels of income inequality (Wilkinson and Pickett, 2006, Mayer and Sarin, 2005).

The **choice of confounders** in the analysis affects the size of the relationship. There is considerable variability in the factors that researchers have controlled for in studies and a lack of clarity about which variables should be included as confounders and which are mediators (i.e. on the causal pathway) (Wilkinson and Pickett, 2006). If factors are mediators, then controlling for them will lead to an underestimation of the relationship. For example, some studies have controlled for factors that are closely related to socioeconomic position, such as education; it is unclear which variables should be considered part of socioeconomic position (Wilkinson and Pickett, 2006). Wilkinson and Pickett note that many of the studies that they had classified as unsupportive of the relationship between income inequality and health showed supportive findings before control variables were added to the analyses.

Multilevel studies on the relationship between income inequality and population health adjust for individual income. Given that income inequality influences individual incomes, which in turn influence health, individual incomes could be considered to be on the causal pathway. Therefore some authors have suggested that it is a mistake to adjust for individual income (Wilkinson and Pickett, 2006) and that it leads to underestimation of the effects of income inequality (Lynch et al., 2000).

On balance, there is increasing evidence that income inequality at the national level is correlated with health and social problems (which have a social gradient within countries). The key questions now focus on explaining this relationship and understanding the causal mechanisms.

Why is there a relationship between income inequality and health?

The presence of a relationship between income inequality and health does not necessarily prove a causal link. There remains significant debate about whether the relationship is causal and, if so, what the causal mechanisms are. A number of interpretations and of the relationship between income inequality and health have been put forward by different authors. These mirror the models for the relationship between socioeconomic position and health.

Absolute income hypothesis (artefact explanation)

Initial studies of the income inequality and health relationship proposed that it can be explained by absolute income at the individual level (Preston, 2007). The absolute income hypothesis hinges on two observations.

First, the artefact explanation has queried whether the relationship between inequality and health is a ‘real’ phenomenon, or whether the curvilinear relationship between individual level income and health gives rise to an artefactual population level association between income inequality and health. Given the curvilinear relationship between income and health at the individual level, there are diminishing health returns of an increase in income at the individual level (i.e. increases in income buy more health for people at the bottom of the income distribution than those at the top). If society were to become more equal, this implies a transfer of income from people at the top of the distribution to those at the bottom, with a resultant small decrease in health for those at the top and large increase in health for those at the bottom. Thus on average the population would be healthier (Gravelle, 1998).

Second, it has been suggested that there are differences in the composition of areas, i.e. that unequal areas have disproportionate numbers of poor people, who have poorer health status, therefore population level health is poorer (Lynch et al., 2004).

However, evidence has built up which suggests that the absolute income hypothesis explains little of the difference in health at the population level. The artefact hypothesis assumes that the effect of income on health at the population level is the sum of the effects of income on health at the individual level, and does not recognise other contextual effects on health (Lynch et al., 2000). However, hypothetical tests of the explanation showed that artefact explanations cannot explain all of the relationship between income inequality and health (Wolfson et al., 1999). Multi-level modelling techniques, which have allowed researchers to control for individual income, have demonstrated a contextual influence of income inequality which cannot be explained by the composition of areas, in terms of people's individual income. Mayer and Sarin explored this in relation to infant mortality and concluded that the relationship between income inequality and infant mortality could not be explained by the curvilinear relationship between family income and infant health (Mayer and Sarin, 2005). Further evidence against the artefact hypothesis is provided by the presence of a relationship between income inequality and health measured between larger areas (national level) but less consistent relationship between smaller areas. If the relationship were explained by the artefact hypothesis, this discrepancy should not occur (Wilkinson and Pickett, 2006).

Income inequality hypothesis

The income inequality hypothesis proposes that inequality has a direct, contextual effect on health that is not due to individual income. As explained above, this is backed up by evidence from multi-level analysis, which has enabled researchers to distinguish between the contextual effects of income inequality, independent of the effects of individual income (or other individual characteristics e.g. gender, ethnicity), i.e. the composition of the population.

How does income inequality have a contextual effect on health? The main arguments have focussed on psychosocial explanations, although neo-material explanations have also been put forward.

Psychosocial explanations

The psychosocial explanations have drawn on the psychosocial explanations for the social gradient in health. Living in a society with high levels of inequality has a range of psychosocial effects on individuals and communities, including increased status differentiation and lower social cohesion. Income inequality acts as a proxy for class differentiation or other forms of social differentiation (Wilkinson and Pickett, 2006).

Psychosocial explanations focus on relative social position. Wilkinson and Pickett have shown that there is little relationship between average income per person and life expectancy (or a range of other health outcomes) among high income countries (Wilkinson and Pickett, 2009b). They therefore reason that population health is not determined by material living standards. Yet there is a clear social gradient in health within countries. They therefore proposed that what matters for health is not a person's absolute income, but their position in the social hierarchy relative to others.

The first pathway that has been identified is through **status differentiation**. People make social comparisons relative to others in their society, which affects levels of stress and negative emotion. As outlined in the previous section, this has a negative impact on health both directly and indirectly by influencing health behaviours.

A number of criticisms have been made of this theory, including that it is unclear which groups people compare themselves to and the relative importance of comparisons with people in the community or further away, e.g. through television (Lynch et al., 2004). This would help to explain whether a person's status relative to local standards or national standards is more important. Evidence that inequality at the national level has a more consistent association with health suggests that national-level comparisons are key (Wilkinson and Pickett, 2006).

The second pathway that has been identified is through **social cohesion or social capital**. Trust is often used as a marker of social capital; people in more unequal countries are less likely to trust other people (Wilkinson and Pickett, 2009b). Despite difficulties in definitions and measurement (Baum, 1999), there is some evidence that social capital has health benefits (McKenzie et al., 2002), although the effects on children's health are unclear. However, the potential dangers of focussing on social cohesion have also been raised. There is concern that disadvantaged groups could be 'victim blamed' for bringing about their own poor health due to a lack of social networks and cohesion (Lynch et al., 2000).

Analyses including measures of social capital in analyses of income inequality and health/development have been conducted to test its role. For example, Gold and colleagues concluded that income inequality affects teenage birth rates largely through the effects on social capital (Gold et al., 2002).

Neo-material explanations

Proponents of the neo-material interpretation of the income inequality hypothesis suggest that income inequality has direct effects on health as a result of material factors and exposures, as well as the level of investment in infrastructure and services (Lynch et al., 2000). These factors may have effects on health behaviours or direct effects on health. More equal countries tend to also have more progressive policies and equitable access to services. The level of income inequality in a society is the result of historical, political, cultural and economic processes. These processes also influence the development of public infrastructure, such as education, health services and housing quality, such that “income inequality per se is but one manifestation of a cluster of neo-material conditions that affect population health” (Lynch et al., 2000).

Therefore, whilst greater inequality will always have a range of psychosocial effects and influence health according to the psychosocial model, the health effects of inequality are not inevitable according to the neo-material model (Lynch et al., 2000). Rather, they can be worsened or attenuated by policies on infrastructure and services. Lynch cites the case of Canada, where there is little evidence of a link between income inequality and health (at a sub-national level), and suggests a list of possible reasons such as universal health care and taxation (Lynch et al., 2004).

Are there alternative explanations?

Lastly, it is possible that income inequality is a proxy for some other characteristic which affects health, for example a cultural tendency or political structure. There are close links between income inequality and social policy (Lynch et al., 2004). However, this explanation has not been tested in relation to health outcomes.

Summary of the links between income inequality and child health

Overall, the majority of studies comparing health in relation to income inequality at the national level have found a relationship between income inequality and poor health, and there is considerable evidence for an effect on child health and development outcomes.

There is evidence that the relationship between income inequality and health is not due to the curvilinear relationship between individual income and health or concentration of the poor in unequal areas. Rather, explanations need to focus on the contextual effects of inequality. Psychosocial mechanisms provide increasingly plausible explanations, particularly the role of status differentiation. However, we need to note that psychosocial effects occur within a structural context. For example, it is possible that status differentiation is less harmful if there is equitable access to decent health services, good quality housing etc. Child health may be affected directly, or indirectly, although there is a lack of understanding on how these mechanisms affect the health of children.

2.4. The welfare state and its relationship to income inequality and health inequality

There is a growing emphasis on the 'politics of health' and the role of the welfare state in shaping health and health inequalities (Beckfield and Krieger, 2009). Research in this field has largely been conducted in parallel with studies on income inequality and health – yet there are numerous overlaps which are useful to consider.

The term "welfare state" is "used as a shorthand for the state's role in education, health, housing, poor relief and social insurance in developed capitalist countries during the post-war period. Public health services, such as health promotion, are also included within this definition" (Eikemo and Bambra, 2008, page 3). Welfare systems include social transfers (e.g. unemployment benefits, child benefit) and the provision of services (e.g. health, education). These processes, their extent and the way that they are organised, in turn affect social and economic stratification, and social relations within countries. The different classifications of welfare states are summarised in Box 2-1.

The relationship between the welfare state and health

A number of studies have found that population health varies in relation to welfare state regimes, e.g. (Eikemo et al., 2008a). Health tends to be best, *on average*, in social democratic regimes.

However, the picture is less clear with regard to the relationship between welfare regimes and *inequalities in health* (Beckfield and Krieger, 2009). Although we would expect health inequalities to be smaller in social democratic regimes and countries with greater redistribution, a number of studies have suggested that this is not the case, e.g. one showed that relative inequalities in morbidity by education status were not smaller in Scandinavian countries (Cavelaars et al., 1998). Some have found associations between welfare regimes and inequalities, for example one study found that the size of inequalities (relative and absolute) in limiting longstanding illness and general health varied between different welfare regimes (Eikemo et al., 2008b). The authors noted that the prevalence of ill health and the extent of inequalities tended to be higher in East European and South European welfare regimes; countries with Bismarckian regimes (e.g. Germany, France, Netherlands) tended to have the smallest inequalities.

There may be a number of reasons for these differences. First, there are methodological differences. Many of the studies assessed relative health inequalities, without also reporting absolute inequalities (so findings are difficult to interpret due to the different prevalence of ill health), as discussed in chapter 3. Also, many of the studies have assessed self-reported health (which, although important and useful, does not relate closely to more objective measures of health, as discussed in chapter 3). Another issue is that welfare regime classifications are crude, and there are a wide variety of institutions and social spending approaches in countries within each regime type, which may influence health in different ways. Analysis of the level of social expenditure (which provides a more nuanced picture) has found that educational inequalities in self-rated health are smaller in countries where social expenditure is higher (Dahl and van der Wel, 2013).

Box 2-1: Classifications of welfare systems

Esping-Andersen's "three worlds of welfare capitalism"

Discussion of how welfare systems affect health and health inequalities has often drawn on work by Esping-Andersen. In his influential book, Esping-Andersen classified welfare states into three different regimes: Liberal, Conservative and Social Democratic (Esping-Andersen, 1990). This division was based on decommodification (the extent to which earnings/welfare are reliant on the market), social stratification and the degree of public and private provision of services.

- In the Liberal welfare regimes (e.g. the US, UK, Canada), state provision of welfare is the smallest and the market plays a dominant role. Social transfers tend to be modest and have entitlement criteria, often with means testing. There is often a division between those who rely on public and private provisions of services.
- In Conservative welfare regimes (e.g. Germany, France), welfare is often related to earnings, with minimal effect on redistribution. The role of the market is smaller, and there is reliance on the family.
- In Social Democratic welfare regimes (e.g. Sweden, Norway), the welfare system tends to include universal transfers and services. Transfers are generous and the role of the state is dominant, with a strong focus on social equality (Esping-Andersen, 1990).

Other classifications

Numerous other classifications of welfare systems have since been put forward (Bambra, 2007, Eikemo and Bambra, 2008). These include Southern welfare systems (e.g. Spain, Italy), which have a large range of welfare types, although they tend to be fragmented, with limited services and no universal coverage. The term Confucian welfare regimes has been used to describe East Asian countries (e.g. Japan, South Korea), with limited government intervention and social welfare programmes and a reliance on the family and voluntary sector. Eastern European welfare states have also been demarcated, in which previous universal services and transfers have been eroded, and the current focus is similar to Liberal regimes, with an emphasis on market mechanisms (Eikemo and Bambra, 2008). Other classifications have also been developed, e.g. reflecting the balance between social transfers and service provision (Bambra, 2007).

It should also be noted that there are considerable variations within different categorisations of welfare regimes, in terms of the types and scale of services and transfers.

How do welfare systems affect health?

Welfare regimes have multiple links to the factors shaping health inequalities and health discussed in this chapter.

First, welfare systems shape social stratification (Esping-Andersen, 1990). Social transfers redistribute between groups in society, and service provision can minimise or reinforce inequalities. This shapes the socioeconomic divisions in society, including the level of income inequality, and, in turn population health.

Second, welfare systems also act as a mediator and moderator of the pathways between income inequality and health and socioeconomic position and health. They may contribute to the effects of living in an unequal country or having a low socioeconomic position on health – or they may buffer these effects. This can be explained using a material/neo-material model. For example, universally provided, high quality child health and education services can reduce the differences in health between population subgroups. However, in countries without universal services, in which socioeconomic groups have differential access to high quality education and health care, services can have different influences on health in different socioeconomic subgroups. Welfare systems are also relevant for psychosocial modes, for example the presence of a social security 'safety net' may reduce the psychosocial effects on health of unemployment. Conversely, means-tested social transfers may be stigmatising, increasing the psychosocial consequences of being at the bottom of the social ladder.

In summary, there is a strong link between welfare regimes and the level of income inequality - they are likely to go hand-in-hand to shape population health and inequalities. Therefore, in this thesis I conceptualise welfare states as a key factor shaping income inequality, and part of the web of factors that lie on the casual pathway, explaining how income inequality and socioeconomic position influence health and health inequalities.

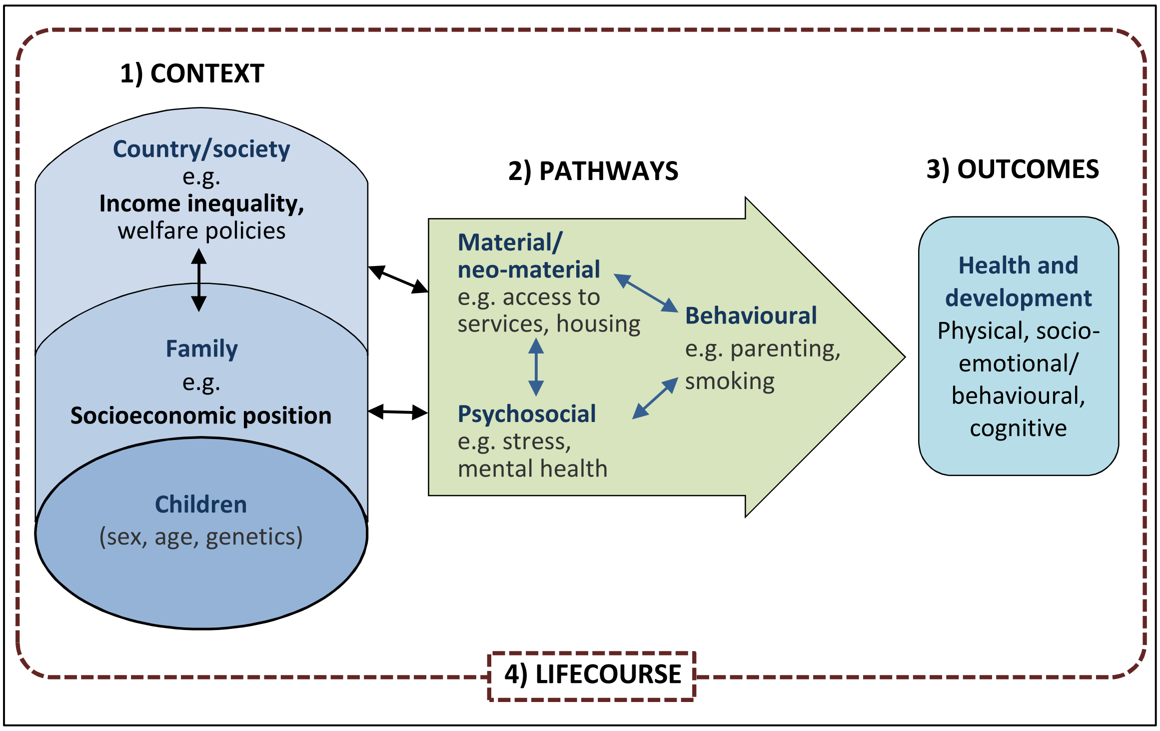
2.5. Pulling it all together – overlapping layers of influence on child health and development

This chapter has reviewed how income inequality (at the societal level) and socioeconomic position (at the family/household level) can influence child health and development. It is useful to summarise these layers of influence with the aid of a conceptual framework.

A number of different frameworks and theories have been put forward to summarise how social/environmental factors 'get under the skin'. Some summarise the overlapping layers of social determinants, e.g. the framework developed by Irwin and colleagues to conceptualise the determinants of early child development and Dahlgren and Whitehead's framework for the social determinants of health (Dahlgren and Whitehead, 1991, Irwin et al., 2007). Others include a focus on mechanisms and pathways, e.g. the framework developed for the Commission for the Social Determinants of Health included the pathways through which structural determinants shape health (they termed these the 'intermediate determinants') (Commission on Social Determinants of Health, 2008).

I have developed a framework to explain how income inequality (at the societal level) and socioeconomic position (at the family/household level) could influence child health and development and to guide my analysis (Figure 2-5). This builds on the literature review in this chapter, and incorporates ideas from previous frameworks, e.g. the 'layers' of influence on health. The framework is a simplified picture – it does not reflect all the possible factors that may influence children's health directly or indirectly.

Figure 2-5: Income inequality, socioeconomic position and child health and development: Context, Pathways and Outcomes framework



The starting point in the framework is children (bottom left corner). Children have a number of individual factors, such as age and sex. They also have a genetic makeup, which influences health. However, we should also bear in mind that genetic expression can reflect social and environmental circumstances earlier in life or even in previous generations due to epigenetic effects (although these pathways are not included in this model as they are beyond the focus on the thesis).

1) Children live within a socioeconomic ***context***, which can be seen in interrelating layers. In reality people live within many overlapping contexts (e.g. schools, neighbourhoods), but two are shown in the framework for simplicity.

- The first layer is the family and household context. Families have a number of characteristics that influence children’s health and development, such as social and financial resources available (socioeconomic position). Other factors, such as the health of household members or culture may also be important.
- Families and households live within a societal context. There are a number of social, economic, policy and cultural factors that are important for health at this level. These include the extent of income inequality (or other forms of social stratification). The type of welfare regime in the society, policies and services are closely related to the level of income inequality. These factors also shape the family and household context.

2) The second part of the framework shows the ***pathways*** through which family and societal context shape children’s health. Three overlapping, interrelated pathways are critical:

- First, there are material and neo-material pathways. Having higher socioeconomic position enables families’ better access to resources, facilities and services, which may influence health. Universal access to services may also help to explain why health and wellbeing tend to be better in more equal countries. Living in a low socioeconomic position in a highly unequal country is therefore particularly detrimental.
- Second, there are psychosocial pathways. For example, low socioeconomic position is associated with higher stress among adults and children. In less equal societies, social hierarchies and levels of social comparison are stressful. Material factors, such as lack of access to health care or poor quality housing may also have psychosocial effects.
- Third, there are behavioural pathways. For example children in households with a low socioeconomic position are more likely to have parents who smoke; the children themselves may be more likely to commence smoking. Material and psychosocial factors are important underlying causes of people’s behaviours, e.g. smoking may be a coping strategy for stressful lives; it is difficult to exercise if leisure facilities are not available.

These pathways may directly affect children themselves, or may affect parents and other household members, with indirect effects on children’s health. For example, children in low income households may themselves feel the effects of status differentiation, with psychosocial effects on their health. Parents and other people that children have close relationships with are also affected by income inequality and their socioeconomic position – for example through stress at work. In turn, this may influence relationships with children or behaviours, such as smoking.

Socioeconomic position and income inequality may interrelate in terms of the pathways. In more equal countries, a low socioeconomic position may be less detrimental to health and development, for example due to an equitable child care services or because there is less status competition. On the other hand, children in a low socioeconomic position in an unequal country may suffer a double burden.

3) The third point on the framework is ***child health and development***, in terms of physical health and development, socio-emotional development or behaviour and cognitive develop. Child health and development are inequitably distributed across society, reflecting the layers of context within which children live – the social gradient. These outcomes may further influence the children's health and wellbeing into adulthood, as well as their own socioeconomic position later in life.

4) The whole process takes place across the ***lifecourse***. It is not static at one point in time; rather context and processes earlier in life may affect the child's health. There are particularly sensitive points in the lifecourse, for example, socioeconomic circumstances, stress and nutrition for the mother whilst the child was in utero may affect their health later in childhood. The effects of earlier experiences may also accumulate as the child grows up.

2.6. Social gradients in health in relation to income inequality?

Although there is clear evidence of the social gradient in health within countries, and of the relationship between income inequality and health at the national level, few have studied how these are related, i.e. how they interact. Few studies have set out to examine whether the social gradient in health differs between more and less equal countries, and whether everyone does better in more equal countries. Other authors have also noted the lack of studies on this topic, for example Rowlingson stated in her recent review of the relationship between income inequality and health:

> "There has been some research… which suggests that those in lower socioeconomic groups in more equal countries do better than those in lower socioeconomic groups in more unequal countries. Indeed, they may sometimes do better than those in higher socioeconomic groups in more unequal countries. Further studies would be very welcome" (Rowlingson, 2011, page 6).

I have reviewed these studies in chapter 4. My comparative cohort analysis in chapters 5-8 adds to this evidence.

2.7. Summary of chapter 2

This chapter has reviewed the evidence on the relationship between socioeconomic position and health within countries, and the relationship between income inequality and health and the national level. In summary:

1) There is a clear, graded relationship between socioeconomic position and health/development at the individual/household level. This gradient exists across the whole of society: each step up the social ladder confers a health and development advantage.
2) A number of models have been put forward to explain the social gradient in health. The materialist and neo-materialist models stress the importance of lacking finances and resources in absolute terms for health, as well as access to infrastructure and services. The psychosocial model emphasises the role of socioeconomic position as a marker of status, rather than material resources, with growing understanding of how factors such as stress and social isolation affect mental and physical health. Behavioural models emphasise the role of healthy or unhealthy behaviours in shaping health. Finally, the lifecourse model shows how people's health is shaped not only by current circumstances, but also by socioeconomic position earlier in their development, in utero or in previous generations. Socioeconomic position is likely to affect health through a combination of material, psychosocial and behavioural pathways; the pathways link and interact and occur throughout the lifecourse.
3) There is a relationship between national wealth and health at the country level among lower income countries, but not among higher income countries.
4) There is a relationship between the level of income inequality and health at the national level. There is a less clear relationship between income inequality and health at the sub-national level.
5) There is good evidence of a contextual effect of living in an unequal society. This can be explained by psychosocial (e.g. status comparisons) and neo-material (e.g. infrastructure and services) pathways.
6) Welfare regimes both shape the level of stratification in society and help to explain the relationship between income inequality, socioeconomic position and health.
7) Few studies have explored how the social gradient in health varies in relation to the level of income inequality in the country.

Chapter 3: Approaches to measuring and comparing socioeconomic inequalities in child health/development and income inequality

This chapter provides an overview of the ways that socioeconomic position, health inequalities and the social gradient, social inequality and child health and development can be measured. I first review definitions of these concepts. I then summarise the options for measurement and then consider the key issues for international comparisons. Understanding these issues is essential for planning and interpreting my comparative cohort analysis, and for reviewing previous studies on the social gradient in relation to income inequality.

3.1. Introduction

The way that socioeconomic position, health and health inequality and income inequality are measured and compared can have considerable implications for findings and conclusions drawn from cross-country comparisons. It is important to consider the range of approaches used, their advantages and disadvantages and the implications for comparisons in order to interpret studies that have conducted such comparisons. It is also essential for planning my comparative cohort analysis of social gradients in child health/development and comparison between countries, and interpretation of my findings.

This chapter gives an overview of how socioeconomic position (section 3.2), income inequality (section 3.3), health inequality and the social gradient (section 3.4), and child health/development (section 3.5) are measured and compared. Within each of these sections, I first give a conceptual overview with definitions of terms used. I then summarise the different approaches to measuring each concept, with consideration of the advantages and disadvantages of each approach. Finally, within each section I consider approaches and challenges to cross-country comparisons.

This chapter contributes to objective 1 of the thesis: *To review approaches to measuring and comparing the social gradient in child health and development.*

3.2. Child socioeconomic position

What is socioeconomic position?

Socioeconomic position (SEP) is a system of stratifying individuals or groups along social and economic dimensions. It has been defined as: "socially derived economic factors that influence what position individuals or groups hold within the multiple-stratified structure of society" (Galobardes et al., 2007, page 23).

As there are many components of SEP, there are numerous means of measuring it. Different approaches to measuring SEP have stemmed from different views of the way that society is structured. For example, the use of occupation as a marker of SEP stems from Marx's definition of social class in relation to production and the inherent conflict between the exploiting owners and exploited workers. Weber defined social hierarchies in a more complex manner, stratified among many dimensions. People have a position and life chances, which are created by individuals, e.g. through education or trade – individuals play a more active role. This classification has informed the use of multiple indicators, e.g. education, occupation and income (Galobardes et al., 2007).

How can we measure socioeconomic position for children and adolescents?

There are numerous approaches to measuring adult SEP, summarised in Table 3-1. These may be single constructs or indices, individual/household or area based, and may aim to capture objective differences or people's subjective social status. These measure different, but related issues. Although they are not always closely correlated, for example, education does not necessarily lead to high income and a high status occupation (Liberatos et al., 1988), different measures of SEP show a graded relationship with health. This relationship may vary depending on the choice of SEP indicator, and the time in the lifecourse at which it was measured (Currie et al., 2008b). Change in SEP over time may also have important implications for health (Nikiema et al., 2012). Such variations may help to reveal the causal mechanisms and sensitive/critical periods for exposure.

Whilst there are a number of useful reviews on measures used for adult SEP, there is relatively little literature on child and adolescent SEP. Many studies have used measures of parental education or occupation or household income as a proxy for child SEP, with limited or no discussion of the appropriateness. However, measuring child and adolescent SEP brings up a number of particular issues and challenges.

Table 3-1: Frequently used measures of Socioeconomic Position

Individual/ household-level	Area-level
• Income • Education level • Occupation, e.g. British Registrar-General Classification, NS-SEC • Expenditure • Wealth/poverty • Housing quality/tenancy • Receipt of benefits • Subjective Social Status (SSS) • SEP indices, e.g. Nam-Powers scores	• Proportion in receipt of benefits • Proportion unemployed • Housing, e.g. o Average value/rent for housing o Housing tenancy proportions • Deprivation indices, e.g. Townsend deprivation index, Index of multiple deprivation

Whose SEP should be measured?

Researchers can seek to measure the child's own SEP or may use parents' SEP as a proxy for the child's SEP. It has been customary to use parental SEP (income/education/occupation) as a proxy for child and adolescent SEP. However, this raises questions about validity – do children have the same SEP as their parents and which parent's SEP (mother/father) should be measured? At what age do children develop their own socioeconomic position?

Children and adolescents are still in education, have little economic power and do not have an occupational status, so the traditional education, income and occupation measures of adult SEP cannot be applied (Currie et al., 2008b). There have been few attempts to measure child SEP directly. Some of these have shown an inverse relationship with parental SEP, for example adolescents whose fathers have lower SEP (measured by occupation) receive less spending money (Currie et al., 1997).

Changing family structures mean that it cannot be presumed that they live with both biological parents. Increasing numbers of children live with step parents. There is also an increase in the number of children with two homes following parental separation, particularly in some of my comparative cohort study countries, e.g. Sweden and the USA (Fehlberg et al., 2011). These changes pose a number of questions, including whether biological or step parents' SEP should be measured, and whether household circumstances reflect the social and economic resources available to the child/adolescent. For example, consider a child living with their biological mother and step father, but spending some weekends with their biological father. Whose SEP is most relevant for the child's health and development? Both the step and biological father are likely to provide financial resources for the child, and provide social support and parenting, therefore both fathers' SEP may play overlapping roles in the child's health and development. Yet studies have not attempted to take this complexity into account.

What are the components of a child's or adolescent's socioeconomic position?

It is often assumed that child and adolescent social and economic status is shaped by the same factors as for adults. Among adults, these differences in social and economic status (by income, education status and occupation) give rise to social gradients in health due to a range of material, behavioural and psychosocial factors (Adler et al., 1994). Among babies and children, gradients have also been well described by parental or household SEP e.g. (Howe et al., 2010, Arntzen et al., 2008). However, among adolescents the evidence on social gradients in health is less clear. There is conflicting evidence on whether and when gradients exist, by parental or household socioeconomic position (Chen et al., 2006, West, 1997, Starfield et al., 2002). This may be because there is less of a social gradient in health during adolescence, or because we are currently using inappropriate measures of socioeconomic position for adolescents. The social and economic factors that are important for health in adolescence may not be the same as the factors that have been traditionally measured for adult and child SEP. During adolescence, individuals begin to develop their own hierarchies and ideas of social stratification (Goodman et al., 2001). These may be important for health, but not fully captured in parental or household measures. There has therefore been a growing emphasis on children and adolescents own perceptions of social and economic hierarchies, e.g. (Sweeting et al., 2011).

Who should report SEP?

Child SEP may be self-reported or may be reported by parents or other family members. There are a number of problems with child report of parental income/education/occupation. Firstly, there are problems with validity. Children often cannot report their parents' education level or income correctly, although reports of parental occupation have higher validity (Lien et al., 2001). There are conflicting reports on the effect of child age, with evidence that reporting improves with age (Ensminger et al., 2000) and evidence of no difference (Lien et al., 2001). Second, there are problems with non-response and missing data, as many children do not know their parent's income/education/occupation. This may lead to selection bias, as non-response tends to be particularly high among children from low SEP households (Wardle et al., 2002, Currie et al., 1997). It has also been suggested that parental income or occupation questions may be considered too sensitive issues for a questionnaire completed by children (Currie et al., 1997). Child-report of household circumstances can be more useful - there is less non-response bias and it is a more valid measure of SEP (relative to child-reported parental occupation education and occupation) (Currie et al., 1997, Wardle et al., 2002).

Parental self-report for parental or household SEP may be more appropriate. However, the feasibility of parental report depends on the study design, the age of the children and the type of SEP measure required. For example, this is feasible within a birth cohort, in which parents and children are followed up, but would be less feasible in a cross-sectional survey of adolescents sampled through schools.

Comparing child socioeconomic position across countries

Comparisons of SEP between countries pose a number of challenges. For example, there are likely to be differences in 'norms' for many indicators, such as housing tenure, education levels or household income levels. There may be differences in the amount of resources required to lead a healthy life, for example due to differences in prices. This needs to be taken into consideration when defining absolute cut-off thresholds for comparisons. For example, countries set different minimum ages for leaving full-time education. In cross-country comparisons, it may be appropriate to set cut-off points in accordance with minimum standards and qualification levels in each country, to allow comparison of all people who had achieved the minimum level of education or lower. However, this may mean that the comparison groups are different (e.g. 11 years of education in one country, 13 in another).

Comparing groups relative to others in society, for example comparing quintiles or using relative poverty rates, may be used to improve comparability. However, using relative measures alone can mask these absolute differences in norms. For example, Bradshaw (2011) points out that the proportion of children below the at risk of poverty threshold was the same in the UK and Estonia at 10% in 2008. However, using a relative threshold meant that the cut-off was considerably lower in Estonia (€9,770 PPP in Estonia, compared with €24,380 PPP per year in the UK), and the poor had considerably lower living standards.

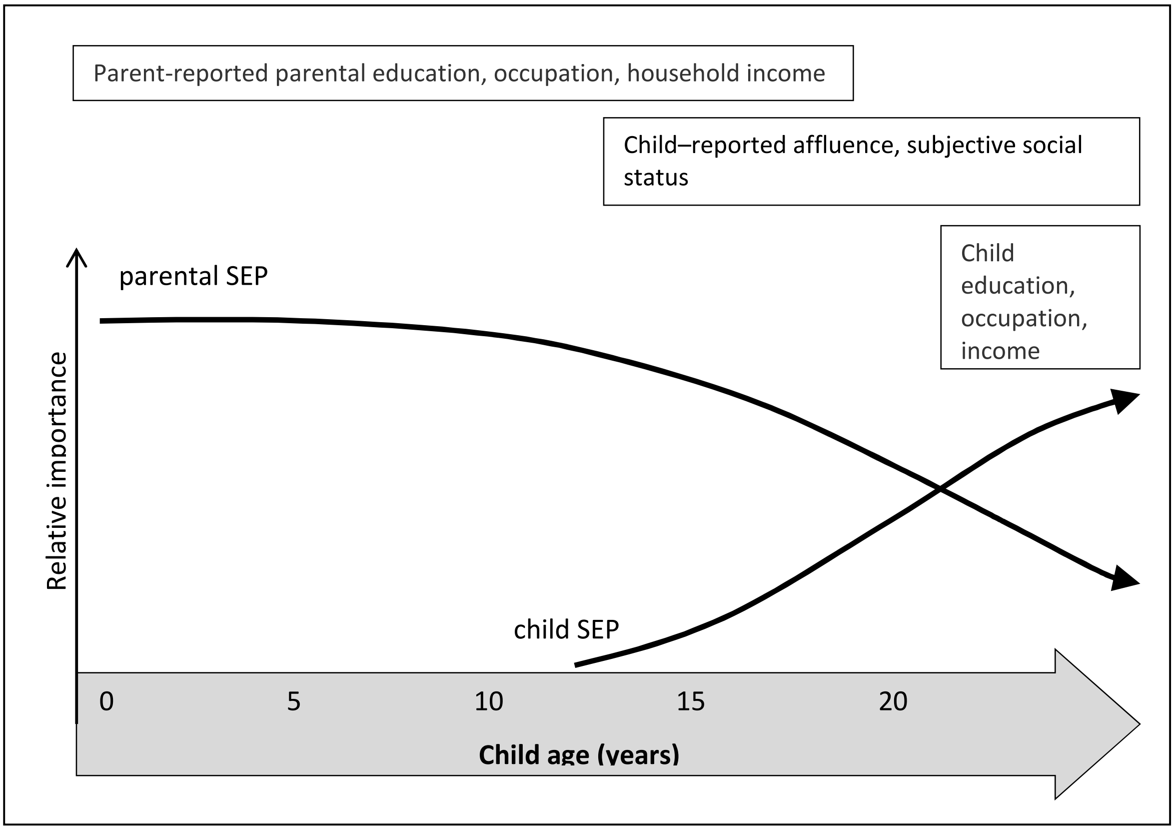
When subjective social status is used, people's self-perceived socioeconomic position may be strongly influenced by perceived norms in the country. They may also be influenced by norms of reporting or cultural values.

There may also be differences in the meaning of different SEP groups, such as different levels of education or occupations. An occupation may have different implications for health in different countries, e.g. due to differences in pay or status associated with the job. These issues are discussed in further detail for specific measures of child SEP below and in relation to harmonisation of cohorts in chapter 5.

Measuring and comparing child SEP: examples of indicators

The following section describes the measures of SEP that are frequently used for children and adolescents. For each measure, I provide an overview of approaches to measurement, and discuss challenges and options for international comparisons. The ways that child SEP can be measured, and relative importance of child and parental SEP in relation to child age, are summarised in Figure 3-1.

Figure 3-1: Relative importance of parental and child socioeconomic position and appropriateness of different measures across the lifecourse



Parental Education

Education status can be measured using the number of years of education or the highest qualification obtained. Parental education is often assessed, using the highest of either parent or the status of one parent (e.g. mother's education level).

Some of the advantages of using education status are that it is easy to measure and response rates tend to be high (Galobardes et al., 2007). Parental education is quite stable over time, so it is unlikely to change throughout the course of a cohort study, for example. In most cases, reverse causality is unlikely; as parents usually completed education before children were born, child ill health is unlikely to affect parental education levels.

However, there are a number of challenges for measurement. There are period effects as education systems and norms of educational achievement have changed over time, which may affect the meaning of education classifications for parents of different ages. Years of schooling does not necessarily reflect the level of education received, e.g. children may skip years; or an additional 3 years of education does not capture the differences in social position achieved from a

3-year college qualification or 3-year degree from a high ranking university. It is difficult to assign an education status to recent immigrants and others who have completed their education overseas. Qualifications can be difficult to arrange hierarchically, especially given the range of academic and vocational qualifications available.

Comparison of education level between countries poses several challenges, due to:

- Differences in education and qualification systems between countries. Most countries have developed national qualification systems, with differences in the qualifications levels and routes. The systems are often complex, with multiple academic and vocational routes, making it difficult to summarise/condense them into categories of education which are comparable. Vocational qualifications can be particularly difficult to compare.
- The timing of key educational milestones and years required to complete qualifications differs between countries. E.g. compulsory schooling starts later in Sweden than the UK.
- Qualifications and years of schooling may have different implications in terms of social status in different countries. E.g. status associated with an undergraduate degree is likely to be higher in a country where few achieve a degree, compared to a country where a large proportion obtain a degree. However, we might expect the implications in terms of knowledge to be more similar. The importance of this needs to be considered in the context of each research question/mechanisms being studied.

There have been two main approaches to comparing education status between countries: categorisation of qualifications to comparable groups (ordinal variable) and conversion to years of education (continuous or ordinal variable).

The International Standard Classification of Education (ISCED) was developed “for assembling, compiling and presenting comparable indicators and statistics of education both within individual countries and internationally. It presents standard concepts, definitions and classifications” (UNESCO, 1996, page 7). The ISCED categories have been used in cross-national studies, e.g. (Bradbury et al., 2010). The ISCED levels are:

- Level 0: Pre-primary education
- Level 1: Primary education
- Level 2: Lower secondary education
- Level 3: Upper secondary education
- Level 4: Post-secondary non-tertiary education
- Level 5: Tertiary education (first stage)
- Level 6: Tertiary education (second stage)

Other studies have developed their own categories to compare education levels. Some have applied the same categories to all countries, e.g. no/primary education, lower secondary education, higher secondary education, and tertiary education (Mackenbach et al., 2008). Others have developed categories with slightly different definitions to take account of different education systems and measurement, e.g. in a comparison of the US and the UK using 3 categories, the US classification was high school or less (0-12 years), more than high school but not a college graduate (13-15 years of schooling), and college or more (≥16 years); the UK classification was lower than "O-level" or equivalent (typically 0-11 years of schooling), qualified to a level lower than "A-level" or equivalent (typically 12-13 years of schooling), and a higher qualification (typically >13 years of schooling) (Banks et al., 2006b).

Years of education is also widely used, although years also reflect differences in education systems as noted above. Some studies have standardised years of education for comparisons (Eikemo et al., 2008b), although this makes findings more difficult to interpret. The number of years of education could also be grouped into ordered categories, e.g. one study used data on highest education certificate to develop harmonised categories of years of education (Martikainen et al., 2001).

Household income

Many studies have used household income or expenditure as a measure of the socioeconomic circumstances in which children are living. Income data can be used continuously or grouped, e.g. at absolute cut-off points or into quintiles relative to the rest of the distribution.

Income may change on a short term basis, so can be useful to investigate changes over time. Equivalence scales may be used to take account of the size and composition of households. This allows analysis at the household level to take account of the fact that, for example, a household with two adults and four children will need a greater amount of resources than a single parent, single child household.

Income can be difficult to measure and there are numerous sources of bias when people report their incomes in surveys. Incomes can be complex, including multiple sources e.g. wages, rent, interest, benefits – and taking taxes into account. Income is a sensitive topic, so people may be reluctant to disclose their income or may have problems with understanding or recall (Galobardes et al., 2007, Moore et al., 2000). Therefore, non-response is often high and people tend to underreport their incomes, both in terms of reporting sources of income and amounts earned (Moore et al., 2000).

A cut-off point may be set, under which children are said to be living in poverty. This may be an absolute level of income, e.g. the World Bank $1.25 a day standard. In high income countries, poverty lines are typically drawn relative to the rest of the population's income, i.e. norms in society. This reflects that people who live in relative poverty " lack the resources to obtain the types of diet, participate in the activities and have the living conditions which are customary, or at least widely encouraged or approved, in societies to which they belong" (Townsend, 1979). The OECD uses a child poverty cut-off of 50% median household income (OECD, 2008). Measures of child poverty allow us to compare the proportion and health status of children in low income households between countries and over time, but do not enable analysis across the social gradient. Furthermore, poverty cut-offs have been criticised for being arbitrary thresholds and difficult for non-experts to comprehend (Bradshaw, 2011). It is also important to note that there is considerable variation in definitions of poverty; many include broader issues than income, such as access to health services and food consumed.

There are many differences between countries which pose challenges for comparisons:

- There are differences in currency, income norms and the cost of living between countries (and between regions)
- There may also be differences in the 'norms' of what components are included in household income (e.g. rent, benefits, employment income) and whether income is measured before or after taxes
- Income is often collected and reported in bands, which can make comparisons difficult
- Income may change considerably over short periods of time and reflect national policies. For example, measurement soon after birth may reflect maternity leave and pay. The implications of timing and policy context therefore need to be considered

Two main approaches have been used to compare across different currencies and costs of living between countries for continuous income. First, comparative studies have converted income data to purchasing power parity (PPP) dollars at one point in time (e.g. 2004 PPP$), for example (Mackenbach et al., 2005). Alternatively, some studies have standardised income (to mean=0, sd=1) to improve comparability (Gregg and Macmillan, 2010), although this makes interpretation more difficult.

Second, comparative studies have used income converted to relative groups (e.g. quintiles/deciles) for analysis, e.g. (Banks et al., 2006b). This approach is simple and removes problems of different currencies.

A large number of different equivalence scales have been developed, but two have been used most widely in comparative studies. The modified OECD scale assigns a weight of 1 for the first adult, 0.5 for additional adults (aged 14 +) and 0.3 for children (aged <14) in the household. Another common approach is the square root of the household size (which has been used in

OECD cross-country comparisons, e.g. (OECD, 2008)), although this scale does not differentiate between the adults and children and their needs. Different scales reflect judgements of the needs of individuals with different ages in the household. Most comparative studies have employed the same scale in each country, although others have used different scales to reflect differences in household economies of scale between countries, e.g. (van Doorslaer et al., 1997).

Parental Occupation

There are numerous systems for classification of occupations into groups on the basis of the level of skill and income for occupations, or people's judgements on the social status of occupations. Many countries have defined their own classification systems, e.g. the UK National Statistics Socioeconomic Classification (NS-SEC, used in MCS) and the Canada Standard Occupation Classification (SOC91, used in NLSCY and QLSCD). Some of these classifications are hierarchical, although others are not (which limits usefulness for analysis). Occupations are often divided into manual and non-manual groups for comparison.

The main advantage of using occupation status is the good availability of data, e.g. through census data (Galobardes et al., 2007). However, there are many problems with using occupation data. Occupation comparisons are often based on father's occupation, as a proportion of women stay at home to raise children (although some studies on children have used the highest occupation status for either parent). A large proportion of households may be excluded or the status may not be captured, including households with a lone mother, voluntary workers, the unemployed and informal or illegal workers (Galobardes et al., 2007).

Occupation can be particularly difficult to compare across countries for the following reasons:

- There are differences in occupational structure (i.e. the proportion in different occupation groups) between countries, making comparisons difficult (Carr-Hill, 1990)
- Countries often use national classification systems, which are difficult to compare
- The proportion of women who stay at home to look after children (so do not have an 'occupation') may vary between countries
- Importantly, particular occupations have different social and economic meanings in different countries, so there may be differences in the lifestyle and status 'norms' for occupation groups in different countries

The International Standard Classification of Occupations (ISCO) system can be used to classify occupations in a comparable way (ILO, 2008), however this system is quite complex and does not seem to be widely used in epidemiology. Some cross-national studies have re-classified occupations to a single classification system, e.g. Leon and colleagues classified Swedish data on father's occupation to the British Registrar General's Scheme (Leon et al., 1992). Others have developed broad occupation categories, such as manual/non-manual e.g. (Kunst et al., 1998). However, even if occupation is classified in a similar way, considerable differences in terms of economic and social meaning between countries are likely to remain.

Household circumstances or benefits

Living standards can be assessed through household circumstances, including tenancy status, housing quality or overcrowding, or measures of affluence or deprivation. The physical conditions of the house are often used as a marker of poverty status in low income countries, such as the roofing or flooring material. However, there are large differences in the 'norms' for many of these factors between countries, making them difficult to compare meaningfully.

Some measures of household deprivation or affluence have been developed specifically for children. For example, the Family Affluence Scale, which was developed in Scotland for use internationally in the Health Behaviour in School Age Children survey (Currie et al., 1997, Currie et al., 2008b). The indicators included in the scale have been modified slightly (to take account of changes in technology over time), and currently include car ownership, child bedroom sharing, computer ownership and family holidays. A similar scale, the Home Affluence Scale, was developed in England and includes free school meals instead of family holidays (Wardle et al., 2002).

The advantages of household affluence scales are that they can be administered to children, for example in classroom situations for school based surveys. They tend to have high response rates (Currie et al., 1997, Wardle et al., 2002). There is a good level of correlation with parental occupation and education (Currie et al., 1997, Wardle et al., 2002) and with Townsend Index (Wardle et al., 2002) and high agreement between parental and child reporting (Andersen et al., 2008). However, a number of factors other than household affluence may affect children's answers to the scale questions. For example, there may be differences in bedroom sharing by family size and by the age and gender of children, which are not taken into account (Currie et al., 1997). There may be differences in car ownership by geographical location (depending on public transport availability, rural/urban location) (Currie et al., 2008b).

Means-tested benefits, such as whether the child receives free school meals, can be used to identify children living in low-income households. Some studies have used receipt of means tested benefits as a proxy for poverty in international comparisons, e.g. (Nikiéma et al., 2010). However, receipt of benefits only provides information on whether households are below a particular cut-off; this is less useful for assessing the social gradient in health. Furthermore, benefit structures and regulations vary considerably between countries, so international comparisons are challenging.

Subjective Social Status

There has been a recent interest in developing measures of subjective social status (SSS), i.e. people's own perceptions of where they stand in the social hierarchy in relation to others. Most SSS scales use a ladder analogy. Participants are asked to place themselves on a rung on a ladder to represent where they feel they stand in relation to reference groups, such as the neighbourhood, country or school. A number of ladders have been developed specifically for adolescents, for example the youth ladder developed as part of the MacArthur Scale of Subjective Social Status.

There are a number of benefits to measuring subjective social status. Firstly, it has been shown to influence health, independent of objective measures of SEP, including for children and adolescents (Goodman et al., 2001). It may be a more useful way of measuring factors that affect health through psychosocial mechanisms.

Secondly, SSS is particularly useful to identify hierarchies and social stratification among adolescents which may not be captured by traditional, 'objective' measures of parental or household SEP. There is evidence that adolescent SSS captures different aspects of status from parental measures; there is weak correlation between adolescent reported SSS and 'objective' parental SEP, e.g. father's education status (Goodman et al., 2001). Adolescent hierarchies may have multiple dimensions. Sweeting and colleagues identified 3 main dimensions of subjective social status among adolescents in Scotland. They asked 15 year olds to place themselves on 7 ladders that related to domains of self-concept and conducted a factor analysis to identify domains of status: 1) peer status, representing 'popular', 'powerful', 'respected', 'attractive' or 'stylish' and 'trouble-maker'; 2) scholastic status, representing 'doing well at school' and 'not a trouble maker' ; and 3) sports status, representing 'sporty' (Sweeting et al., 2011).

Thirdly, SSS may be more sensitive to some forms of hierarchy. Many of the objective measures are not sensitive to the differences in status that may exist within categories. Adler gives the example of college graduates – whilst objectives measures of education would see all graduates in the same way, there may be differences in status and life chances between those who graduated from a high-ranked college compared to a lower-ranked college. These status differences can be captured using a subjective measure of socioeconomic position (Adler and Stewart, 2007).

However, there are a number of potential disadvantages. There may be response bias. People who rate themselves highly on a ladder may also report better health due to a response set. On the other hand, people who experience negative affect or are depressed may rate themselves low on the ladder and report poor health. However, studies have shown relationships between SSS and objective measures of health (Adler and Stewart, 2007). Reverse causality may also explain relationships – adolescents who experience poor health may be more likely to rate their own social status as low. Comparisons between countries may be complicated by differences in response 'norms'.

Area-based measures

Area-based measures could include the median income in the area, the mean education level, crime rates, area deprivation levels etc. The characteristics of the area that children live in can be used as a proxy for individual or household SEP when individual data are not available. They are also used to assess contextual effects of living in areas with particular levels of socioeconomic development. There is a need to be aware of the potential for ecological fallacy when drawing conclusions about individual-level relationships from aggregated data. Also, when areas are large the variation within areas needs to be taken into account. Comparing associations between SEP at the area level and health tends to underestimate the association with health outcomes (Galobardes et al., 2006).

Area-based deprivation indices are widely used to allocate resources and plan interventions in the UK. Commonly used indices are the Townsend deprivation index, the Carstairs deprivation index, the Jarman or underprivileged area score, Breadline Britain (based on what people consider a minimum standard of living) and the Index of Multiple Deprivation. The indices have the advantage that they can include a variety of factors that affect health in one index. This can be useful if you are adjusting for SEP, as it reduces the chance of residual confounding. However, this may not be helpful for understanding the mechanisms through which SEP affects health.

Two issues are challenging for international comparisons of area-based measures. First, different countries have different 'norms' for many of the indicators that are used at an area level, e.g. type of housing. Second, comparisons are complicated by differences between countries in the size of areas that statistics are aggregated to. Different countries use different areas for comparisons, e.g. in the US zip codes are often used; the UK often uses wards or Super Output Areas. Imagine a city with small affluent and deprived neighbourhoods (i.e. 'pockets' of affluence and deprivation). If affluence is measured using small areas, these differences between small neighbourhoods should be captured, and differences in mean affluence (and probably differences in health) will be large. If, however, areas are defined at a larger size, these 'pockets' are likely to be averaged out in the statistics. As a result the differences in affluence will appear smaller (and differences in health outcomes are also likely to look smaller).

3.3. Socioeconomic Inequality

What is socioeconomic inequality?

Socioeconomic inequality can be defined as the unequal distribution of social or economic resources or opportunities between individuals or groups. Inequalities exist along many economic and social dimensions in society. For example, we could identify inequalities in economic/material wellbeing such as income, consumption or wealth, or in terms of social issues, such as health, education or power. Much work has focussed on inequality of outcomes, such as income earned or life expectancy. However it is also important to consider inequalities of opportunities and life chances, which may help us to understand the processes behind differences in outcomes and develop policy responses (McKay, 2002). Inequality can refer to differences between individuals, or between a wide range of groupings of people, including households or families, age groups or ethnic groups, communities or schools, or geographical areas or countries. Finally, we can think about inequalities in different timeframes. Measures of inequality tend to be based on data that were collected at one point in time. However, some aspects of people's living conditions, such as income, tend to vary over time (within a year and over the lifecourse), and longer timeframes can be useful (McKay, 2002).

Despite this wide range of ways to frame inequality, research on socioeconomic inequality has tended to focus on inequalities of income between individuals or households. This is partly because income data tend to be relatively readily available. Income inequality can be interpreted in a narrow sense – in terms of wellbeing only in relation to the amount earned. However, it is often interpreted in a wider sense, as a summary or proxy of the degree of wider inequality of economic resources or social factors, such as status or power in society.

However, there are disadvantages to focusing on income. Income is time-limited (typically income over the last 12 months). This ignores wealth that has accumulated in previous time periods. Disparities in wealth are far wider than inequalities in income, as a result of this accumulation of assets across generations and over the lifecourse. Therefore focusing on income inequality, rather than wealth inequality, understates the degree of economic inequality in society (OECD, 2008). However, wealth is very difficult to measure and data are difficult to obtain. A focus on income also ignores the role of benefits in kind, for example the benefits from public services, such as health or education services. If the provision of such services removes the need for households to pay out of pocket, they have an equalising effect. However, it is difficult to measure benefits in kind and their interpersonal distribution.

In this thesis I use income inequality as a marker of socioeconomic inequalities within countries. I use a wide interpretation of income inequality as a marker of differences in income received, as well as a proxy for wider social and economic differentiation. As I am using income inequality, I continue this discussion with a focus on measuring and comparing income inequality.

How can we measure income inequality?

There are many measures used to summarise the degree of inequality in incomes in a population. This section provides a summary of measures that are widely used, and issues to consider.

Inequality may be driven by differences between household or individual incomes across the whole income distribution, or by large differences particularly at the top or the bottom of the distribution. Either lots of people living in extreme poverty, or lots of people living in extreme affluence could lead to inequality. When summary measures of inequality are presented, it is not always clear where inequality is worst in the distribution.

Given that different measures of income inequality have particular sensitivity to different parts of the income distribution, using different measures to rank countries in terms of the level of income inequality may result in a different order of ranking. Furthermore, the use of different measures of inequality may affect the size of the relationship between income inequality and health (Laporte, 2002). Some studies have compared the use of different indicators of inequality in analysis of the effects of inequality and health. However, these studies have had conflicting findings. Kawachi and Kennedy found that there was a high level of correlation between different indicators (Gini coefficient, decile ratio, proportion of income earned by the poorest 50%, 60% and 70% of households, Robin Hood index, Atkinson index and Theil's index). They concluded that the choice of indicator had little effect on analysis of the relationship between income inequality and health (Kawachi and Kennedy, 1997). In contrast, more recent studies have found that the choice of inequality indicator does affect the relationship between inequality and health. Weich and colleagues found that there were differences between the Gini coefficient and the generalised entropy index in terms of the relationship found between income inequality and health (Weich et al., 2002). Some have suggested that it is important to use a variety of different measures, in order to examine the effects of income inequality at different parts of the income distribution (De Maio, 2007).

The most common measures of income inequality are summarised in Table 3-2. Each measure has strengths and limitations and there is no single best measure. I describe three in detail, which have been widely used in public health research and in studies on the relationship between income inequality and health: the Gini Coefficient, the General Entropy Index and the decile ratio.

Table 3-2: Measures of income inequality

Measure	Description	Strengths	Limitations
Gini coefficient	• The area between the Lorenz curve and the 45 degree line of equality, divided by the area under the line of equality • Usually presented as a value between 0 and 1 (1=complete inequality; 0= complete equality) • Sensitive to transfers between the top and bottom of the income distribution	• Generates a single summary statistic • Widely available	• Does not show whether greatest inequality is at the top or bottom of the gradient, or where change occurs • Particularly sensitive to inequalities in the middle of the income distribution • Difficult to decompose
General Entropy (Theil index)	• Based on calculation of each individual's ratio between their share of total income to the share of the population • Includes a sensitivity parameter which can be varied to place more weight on different parts of the income distribution • Values range from 0 to infinity (higher values indicate greater inequality; 0 = equal distribution) • Theil's index is the GE index, using a sensitivity parameter of 2	• Allows sensitivity to different parts of the income distribution. • The value can be decomposed to explore different population subgroups	• No upper bound to values. This makes it difficult to compare values • Does not show whether change happens at the top or bottom of the income distribution • Not very intuitive or easy to interpret
Atkinson Index	• Collection of measures • Uses sensitivity parameters to place more weight on different parts of the income distribution (0 if indifferent to where inequality lies in income distribution; positive numbers are more sensitive to inequality at the bottom of the income distribution) • Values range from 0-1 (0=perfect equality).	• Allows sensitivity to different parts of the income distribution. • The value can be decomposed to explore different population subgroups	• Not very intuitive or easy to interpret
Proportion share of income	• Can calculate for relative groups e.g. deciles, quintiles of the population. Creates 5 or 10 percentages, often presented in a table • Can also calculate a single figure for the poorest x% of population	• Simple to calculate and understand • For deciles/quintiles - shows the distribution of income across the whole income distribution • Useful to show changes in the share of income in groups	• For deciles/quintiles – 5 or 10 figures are generated – no summary measure. This can make it difficult to compare countries • Gives limited information on the income distribution

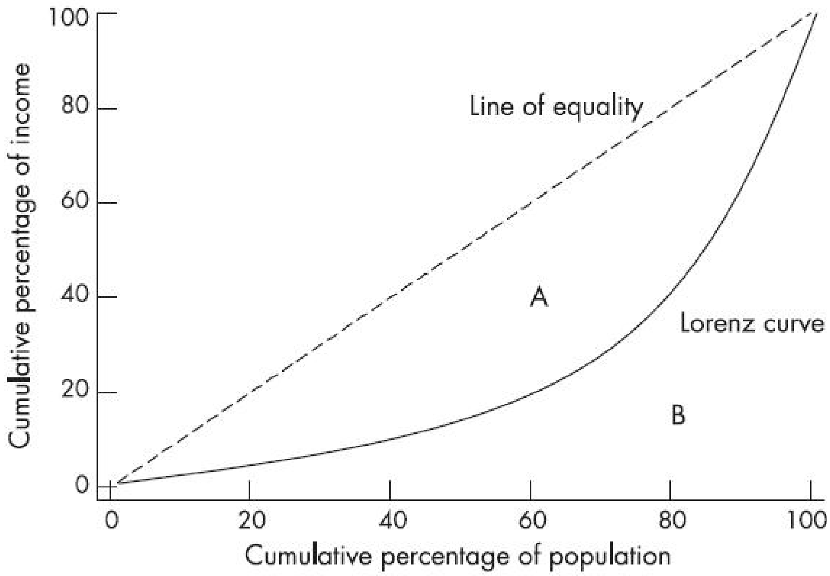
Measure	Description	Strengths	Limitations
Decile ratios and Palma index	• Compares income earned by one (or more) deciles with income earned by another decile(s) of the income distribution. E.g. a ratio of income earned by the top 10%: income earned by the bottom 10% of the income distribution • Palma index is calculated as the ratio of the top 10% to bottom 40%	• Simple to calculate and understand • Can calculate and compare ratios of different proportions of the population (e.g. 90:10; 80:20)	• Only provides a ratio of top to bottom; does not summarise inequality across the whole income distribution
Robin Hood index	• Calculated as the maximum vertical distance between the Lorenz curve and the line of equality • Can be interpreted as the proportion of income that needs to be transferred from people above the mean income to people below the mean income in order to achieve equality of incomes • Values range from 0%-100%; higher values indicate a higher level of inequality	• Easy to understand	
Coefficient of variation	• Calculated using the standard deviation of the income distribution divided by the mean • Higher values indicate higher inequality (as the standard deviation of income will be higher in more unequal countries)	• Simple to calculate and understand	• No upper bound (which makes values difficult to compare) • Coefficient can be influenced by very high or low values • Use has been limited in public health research
Sen poverty measure	• Incorporates both a poverty and inequality measure • Includes the Gini coefficient for people living below the poverty line and the average income of people below the poverty line	• Useful if the study focuses on inequality among the poor	• Does not tell you about inequality in the middle or top of the distribution • Use has been limited in public health research
Variance of income distribution	• Variance or standard deviation of income distribution	• Very simple to measure	• Dependent on the income scale and overall level of incomes (doubling all incomes would lead to a quadrupling of inequality)

Sources: (Ellison, 2002, De Maio, 2007, Litchfield, 1999)

The Gini Coefficient

The Gini Coefficient is very widely used and has been employed in many analyses of the relationship between income inequality and health/wellbeing, e.g. (Kennedy et al., 1998, Beckfield, 2004, Elgar et al., 2009). It is calculated from the area between the Lorenz curve and the line of equality (Figure 3-2). The Lorenz curve shows the cumulative percentage of the population on the x axis and cumulative percentage of income on the y axis. A perfectly equal society would have a straight line at a 45 degree angle – the line of equality (i.e. 20 % of the population have 20% of the income etc.). The Lorenz curve shows the real (in this case hypothetical) distribution of income: 20% of the population earn approximately 3% of the income, 30% earn approximately 8% and so on. The more the Lorenz curve deviates from the line of equality, the more unequal the society is.

Figure 3-2: The Lorenz curve (hypothetical data)



Source: (De Maio, 2007)

The Lorenz curve provides a clear and comparable visual summary of the degree of income inequality in the society. The Gini coefficient is widely available and used in public health research and generates a single summary statistic, which is useful for comparisons (De Maio, 2007). However, it is particularly sensitive to inequalities in the middle of the income distribution (De Maio, 2007, Ellison, 2002), which may not be appropriate for all studies. Furthermore, it does not differentiate between different types of inequality (De Maio, 2007). For example two different income distributions, one with wide inequality at the top of the distribution and one with wide income inequality at the bottom may have the same coefficient. Further, if there have been changes in the Gini coefficient over time, or there are differences between countries, it is not clear where the differences took place in the income distribution.

The General Entropy Index

The General Entropy (GE) Index has been less widely used, but has been employed in some studies of income inequality and health, e.g. (Macinko et al., 2004). The GE index is a collection of measures of inequality, which are based on a calculation of each individual's ratio between their share of total income to the share of the population. The index values range from 0-infinity (higher values indicate greater inequality; 0 = equal distribution). The index includes a sensitivity parameter which can be varied to place more weight on different parts of the income distribution. Usually, parameters from -1 to 2 are used, with higher numbers more sensitive to inequalities at the top of the income spectrum (De Maio, 2007). The GE index using a sensitivity parameter of 2 is known as Theil's index. This flexibility allows sensitivity to different parts of the income distribution, for example it would be possible to investigate which parts of the income distribution were most important by repeating analyses with different parameters. Furthermore, unlike the Gini coefficient, it is possible to decompose the GE value to explore different population subgroups (De Maio, 2007).

However, there are a number of problems with the GE index. Firstly, it is less visual and intuitive than the Gini coefficient. The lack of an upper bound to values makes it difficult to compare the level of inequality over time or between countries. As with the Gini coefficient, if change in inequality occurs, it does not show whether change happens at the top or bottom of the income distribution (De Maio, 2007).

Decile ratios

Decile ratios compare the income earned by one (or more) deciles with income earned by another decile(s) of the income distribution, for example a ratio of income earned by the top 10%: income earned by the bottom 10% of the income distribution. This measure has been used in research on inequality and health, for example in The Spirit Level (Wilkinson and Pickett, 2009b). The main advantage of this method is that it is very intuitive, simple to calculate and understand. It is also possible to explore which sections of the income distribution are particularly important for health by calculating ratios of different proportions of the population (e.g. 90:10; 80:20) (De Maio, 2007). There has been growing interest in the use of the Palma index, which is calculated as the ratio between the income share of the top 10% and bottom 40% of the population (Cobham and Sumner, 2013). However, the measure only provides a ratio of the top to the bottom; it does not provide information about inequality across the whole income spectrum.

Comparing income inequality

The comparability of income inequality measures between countries or over time depends on two issues: a) comparability of measure used, and b) comparability of the data.

a) Comparability of measures

In order for a measure of inequality to be comparable, it needs to meet a number of criteria, including:

- Pigou-Dalton transfer principle - a transfer of income from a poorer to a richer individual (which does not affect the mean income) will result in an increase in inequality; conversely, a transfer from a richer to a poorer individual (which does not affect the mean income) will result in a reduction of inequality (Litchfield, 1999).
- Mean-independence (or income scale independence) - the measure summarises only inequality and not the mean absolute level of income. So a difference between countries or change over time in the overall, mean level of income will not affect the measure of income inequality. A change in the currency used would not affect the level of inequality (Litchfield, 1999).
- Principle of population – the level of inequality is not affected by the size of the population; adding together two identical income distributions would not have an effect on the level of inequality (Litchfield, 1999).

The Gini coefficient and the GE index are widely used in comparisons of income inequality between countries and satisfy these criteria.

b) Comparability of the data

As discussed in section 3.2, the measurement of incomes is complex. Income data can be collected in many different ways, and can be unreliable. There are considerable differences between income inequality estimates produced by different sources (and different countries), such that using different sources affects the comparisons made between countries and over time (Atkinson and Brandolini, 2001).

It is often difficult to judge whether the data that have been used in calculations of inequality are comparable. Single summary figures are often reported, with little or no information about the data used. Therefore, it is often unclear which source the income data are from (e.g. tax records or surveys) and the quality of the data. For surveys, there are differences in response rate and whether the sample is representative of the country (or just urban or rural, for example). For tax records, there may be concerns about coverage or underreporting of incomes (Atkinson and Brandolini, 2001). There are differences in definitions and calculations, for example estimates may use income or expenditure data. It is often unclear how income was defined and calculated and whether it includes other sources of income such as interest, whether it is gross or net income. Income may be measured at the individual or household level, and if at the household level may be equivalised or not. There are also issues with the timing of data collection and differences in how people who are present for only part of the time period are treated in the calculations (Atkinson and Brandolini, 2001).

There have been some attempts to compile comparable income data and measures of income inequality. The Luxemburg Income Study has compiled estimates using comparable surveys and methods, however these estimates are only available for a limited number of countries. The SWIID (Standardized World Income Inequality Database) has produced standardised Gini Coefficients for 157 countries, over time, using the United Nations University's World Income Inequality Database and data collected by the Luxembourg Income Study (Solt, 2009). This project aimed to provide data for cross-national research, and has been used in studies comparing income inequality between countries and over time, e.g. (Avendano, 2012) .

3.4. Health inequality and the social gradient in health

What are health inequality and the social gradient?

Health inequality has been defined as “differences, variations, and disparities in the health achievements of individuals and groups” (Kawachi et al., 2002, page 647). Whilst health inequality is a neutral term that describes the extent of differences, without any moral judgement, the term health inequity has been used to capture a moral element: “The term inequity has a moral and ethical dimension. It refers to differences which are unnecessary and avoidable but, in addition, are also considered unfair and unjust. So, in order to describe a certain situation as inequitable, the cause has to be examined and judged to be unfair in the context of what is going on in the rest of society.” (Whitehead, 1992, page 5).

There is some debate about what should be considered ‘fair’ or ‘unfair’ and ‘avoidable’ , and which term to use (Kawachi et al., 2002). However, in practice, the terms are now often used interchangeably. The term ‘health inequality’ is often used as a ‘catch-all’ term, incorporating differences that are unfair and avoidable.

In this thesis I have decided to use the term inequality. This is partly because it is widely used and accepted in the literature. In general, differences in health and development between young children from different socioeconomic groups are considered unfair – I do not feel that it is necessary or useful to label some differences as inequalities and some as inequities, rather I use health inequalities to capture all differences. Furthermore, by considering the effects of living in an unequal society on people at different points on the socioeconomic hierarchy, we may challenge some of the previous assumptions of what is ‘fair’ or ‘unfair’.

The term ‘social gradient’ has been employed to describe the graded relationship between socioeconomic position and health: that every step up the social ladder confers a health advantage.

In my thesis I am focussing on the gradient in health across the whole of society (rather than differences between those below a cut-off point for disadvantage and others). However, in the following sections I give an overview of measures used for both of these approaches, highlighting measures that are appropriate for assessing inequalities across the social gradient.

How can we measure health inequality?

Many diverse methods of measuring health inequality have been used. These fall into a number of categories:

Measures of disproportionality provide summary measures of the share of health in relation to share of population. They have also been used in relation to socioeconomic variables, e.g. the share of health in relation to share of income. In these measures, individuals are ranked, e.g. according to income. Such measures include the Gini coefficient, Index of Dissimilarity and Theil Index and Mean Log Deviation.

Absolute and relative bivariate measures summarise the degree of difference in health in relation to another dimension, e.g. how health varies according to socioeconomic position, ethnicity etc. Absolute measures summarise the absolute difference in health/ill health between groups; relative measures summarise differences relative to other groups, e.g. using ratios. Some measures summarise differences between two or a small number of social groups, so often provide information on differences between extreme groups, rather than summarising the gradient. Other summarise the degree of difference in health/ill health across the whole social gradient (e.g. the SII). The frequently used absolute and relative measures, their strengths and limitations, are summarised in Table 3-3.

The measures presented are useful, but none of them can be used alone to summarise the social gradient in health.

Table 3-3: Measures of health inequality

Measure	Description	Strengths	Limitations
Absolute measures			
Absolute difference in health	• The difference in health or ill heath between different groups (e.g. years of education, income quintile) • Often compares top or bottom groups, but can compare many different groups e.g. three different education levels	• Simple to calculate and interpret • Can calculate the number of cases that would be prevented/lives saved if one group had the same level of health/ill health as the other	• May neglect what is happening among intermediate groups • May not take account of the proportion of the population in the groups (unless using deciles/quintiles) • Depends on the prevalence of the outcome (for low prevalence conditions, absolute differences will be low; for higher prevalence conditions absolute differences will be higher). If prevalence falls over time, absolute differences may decrease as relative differences stay the same or increase. • Best to use in conjunction with a measure of relative differences
Linear regression coefficient	• Shows the average absolute increase/ decrease in health for each 1 unit change in SEP	• Simple to calculate	
Slope index of inequality (SII)	• Calculated by converting SEP into a score from 0-1 and weighting each score by the proportion of people in the socioeconomic group. Then regress the weighted scores with the health outcome for each group. The regression coefficient is the slope index of inequality • Can be interpreted as the absolute difference between the socioeconomic best off and worst off	• Takes account of the proportion of people in each group, so useful for comparing different populations • Useful for comparing different outcomes or different SEP measures, as all SII measures are on the same scale • Not heavily influenced by extremes of SEP	• Need to be careful interpreting. Although SII measures are on the same scale, if different SEP exposure categories were used, or different populations, the SII does not have the same meaning • Not useful for binary measures of SEP (difference between the 2 groups will always be the same) • Assumes that everyone in the worst off group is worse off than people in the next group – not likely • Needs a hierarchical SEP grouping
Relative measures			
Ratios (Relative difference) in health	• The ratio between a measure of health or ill health in one group and in another group (e.g. income quintile) • E.g. odds ratios, risk ratios • Often compares top or bottom groups, but can compare many different groups e.g. three different education levels	• Simple to calculate and interpret	• Can neglect what is happening among intermediate groups and the social gradient, if only comparing top and bottom groups • May not take account of the proportion of the population in the groups (unless using deciles/quintiles)

Measure	Description	Strengths	Limitations
Relative concent-ration index	• Measures the amount to which health or ill health are disproportionately concentrated among certain groups • Derived from a Lorenz curve and calculated in a similar way to the Gini coefficient. The x axis is the cumulative percentage of the population, ranked by socioeconomic position. The y axis is the cumulative proportion of total health/ill health. The Lorenz curve represents the cumulative proportion of health for each proportion of the population, ranked by socioeconomic position.	• Reflects inequalities in health across the social gradient • Reflects population size of different groups • Can be shown on graphs	• Can only use socioeconomic groups that can be ranked • Has not been used widely in health inequalities research
Relative index of inequality (RII)	• Calculated as the slope index of inequality divided by the mean value of the outcome • Can be interpreted as the relative difference in health/ill health between the socioeconomic worst off and best off	• See SII for strengths	• Can be misleading if reported alone for time trends. RII can increase even if absolute inequalities have decreased over time, if overall rate of ill health falls proportionately more than absolute gap. • See SII for other limitations

Source: (Shaw et al., 2007, Frank and Haw, 2011)

How can we measure the social gradient in health?

The term 'social gradient' is often used to represent the slope of the gradient, or the size of absolute or relative inequalities in health. However, Willms has suggested that social gradients can be broken down into 5 components: the level, slope, strength, length and linearity (Willms, 2003, OECD, 2010). Taken together, these components summarise the nature of the relationship between SEP and the health outcome. These components are summarised in Box 3-1.

The possibility to examine components of the gradient depends on the type of data available. Willms and colleagues used a continuous SEP variable to examine all 5 components (Willms, 2003). However, if data are categorical, it may be difficult to assess length, for example. The way that the SEP and health data are grouped also affects our interpretation of these components. For example, if SEP data are grouped into relative groups, e.g. quintiles, the slope also reflects the length of the gradient (i.e. a steep slope could be due to large inequalities in health or large differences in SEP). The implications for international comparisons of the slope are considered below.

In this thesis, I am particularly interested in the level and slope of the gradient in order to answer my research questions:

- How does the *slope* of the social gradient vary in relation to income inequality? (Is the gradient steeper in more unequal countries?)
- How does the *level* of the social gradient vary in relation to income inequality? (Is health worse overall in more unequal countries?)
- *Does everyone do better in more equal countries*? (comparing both the slope and level of the gradient)

No single measure can summarise all of the components of the gradient, and it may be necessary to report several measures to give an overall picture. Graphing the gradient gives an immediate visual summary of all of the components.

Box 3-1: The 5 components of the gradient

The **level** (or **height**) of the gradient is the outcome after taking SEP into account, i.e. outcome expected for a person with average SEP (or other particular level of SEP). This is assessed using the outcome for child with mean SEP (note that this is different from mean outcome, as it controls for SEP).

The **slope** of the gradient line is the steepness of the relationship between outcomes and SEP, i.e. how much the outcome changes, on average, for every 1 unit change in SEP. This can be assessed using regression coefficients, or other single summary bivariate measures of health inequality.

The **strength** of the gradient is the proportion of variance in the outcome explained by SEP, i.e. amount of variation of individual data points from the gradient line. This can be assessed using the R-squared from linear regression, or from Pearson's correlations.

The l**ength** of the gradient line is the extent of differences in SEP in the population, i.e. socio-economic inequality (a longer line means greater socioeconomic disparities in the population). For example, income may range from £0 to £10,000 per week in the population. This can be assessed using the range of SEP values in the gradient line.

The **linearity** of the gradient line is the extent to which the difference in outcome associated with SEP remains constant across levels of SEP, for example the gradient may be steep at low SEP and tail off for high SEP. This can be assessed by checking for linearity in regression models, and adding a squared term.

Comparing health inequalities and social gradients

As with comparisons of SEP or income inequality, a number of issues need to be considered when comparing health inequalities or gradients between countries. First, as discussed in relation to income inequality, the implications of differences in the data source, the way data have been collected and the quality of the data always need to be taken into account. If routine data are used, the reliability and completeness needs to be considered to minimise error (Frank and Haw, 2011).

Second, we need to be aware that choosing absolute or relative measures to summarise differences in health between socioeconomic groups can lead to very different conclusions (Moser et al., 2007, Vågerö and Erikson, 1997). In particular, where absolute risks and absolute risk differences are low, relative differences can be large. For example, Mackenbach and Kunst concluded that inequalities were greatest in Sweden and Norway in a between-country comparison of inequalities in mortality and morbidity in Western Europe (Mackenbach and Kunst, 1997). They measured relative inequalities, i.e. how many times greater the mortality rate is among people with high SEP than those with low SEP in each country. However, they did not take account of the very low absolute levels of mortality and morbidity in these countries. Vågerö and Erikson responded that relative measures cannot be interpreted in isolation (Vågerö and Erikson, 1997). Very different conclusions would be drawn from absolute figures: the absolute risk differences between the high SEP and low SEP groups are relatively small in Sweden and Norway. Several authors have therefore suggested that relative measures should only be reported in conjunction with absolute measures, e.g. (King et al., 2012).

It is also important to note the implications of comparisons using relative or absolute SEP groupings. For example, a comparison of the difference in health between those who earn less than £15,000 per year and those who earn more than £50,000 per year (absolute groupings) in two countries gives us information about the size of the differences in health. If, on the other hand, we compare differences in health by relative SEP groups, between those in the bottom decile of income with those in the top decile of income, the comparison also reflects the size of inequalities in earnings the two countries. For example, if the differences are large, this could be due to a steep social gradient (i.e. large differences in health status), or could be due to a shallow but long social gradient (i.e. small differences in health status, but large differences in income). This can be confusing if the range of SEP values is not known.

3.5. Child health and development

What is child health and development?

The WHO definition of health has been widely accepted: "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity" (WHO, 1946). This definition sees health in a positive way, and incorporates mental and social domains as well as physical health.

It is useful to identify the key components of child health and development. Authors have used different categorisations, for example a recent report on child development identified five domains: physical, social, emotional, communication, and language and cognitive skills (Geddes et al., 2010). Bradley and Corwyn identified physical, socio-emotional and cognitive domains (Bradley and Corwyn, 2002). I have adjusted the domains of development proposed by Bradley and Corwyn in order to incorporate physical, social and emotional health and health behaviours. The three domains that will be used throughout this thesis are:

- Physical health and development
- Social-emotional development and behaviour
- Cognitive development

How can we measure child health and development?

There are numerous approaches to measuring child health and development, which cannot all be discussed in this section. A few examples are provided for each of the three categories of health and development in Table 3-4 below. I have provided further information on the specific measures I have used in the comparative cohort analysis in chapter 5.

Measures can be objective, for example objectively measured height, or subjective, for example self-rated health. Some indicators may be measured in an objective or subjective manner, for example child obesity can be measured (e.g. using BMI) or parent-reported. Measures may assess positive aspects of health and development, for example perceived health, or negative aspects of ill health, such as asthma prevalence.

For continuous variables, population averages are often used, e.g. mean or median BMI, or a cut-off point can be set, e.g. the proportion obese. For health conditions, researchers often report the incidence or prevalence in the population, e.g. prevalence of asthma. Alternatively, we can incorporate the severity of the condition, using measures such as hospitalisations due to asthma. The social gradient may vary depending on how health is conceptualised. For example, gradients in severe conditions or hospitalisation may be steeper if conditions are not managed as well among people in disadvantaged circumstances.

Table 3-4: Measures of child health and development

Physical health and development	Social-emotional development and behaviour	Cognitive development
E.g. • Infant mortality/post-neonatal mortality/child mortality • Height • Overweight or adiposity • Disease prevalence e.g. asthma • Self or parent-rated health	E.g. • Behavioural problems • Health behaviours, e.g. smoking • Teenage suicide rates	E.g. • Literacy (reading/language, mathematics, science) • School readiness (may include physical and socio-emotional development) • IQ • Other problem-solving tasks

Comparing child health and development across countries

Comparisons of child health and development across countries suffer from similar challenges to comparisons of SEP and inequality. These fall into three categories: a) Definitions and measurement, b) Data sources, c) Analysis. These challenges need to be taken into account when choosing child health and development indicators and when interpreting the findings of cross-country comparisons.

I explain each of these challenges below, with examples drawn from international comparisons of infant mortality, life satisfaction and cognitive ability. I conducted additional work on problems with international comparisons of infant mortality - this is provided in Appendix 3.

Differences in definitions and measurement

Although there are clear definitions for most indicators, there may be differences in the way that components of the indicators are defined, or differences in the way that they are measured in different countries.

Infant mortality is an interesting example. There is one clear definition for the equation used to calculate the indicator: the probability of dying between birth and age 1 per 1000 live births. However, the measurement of the indicators used in this calculation is less clear – there are differences between countries, hospitals and individuals in the recording of both infant deaths and live births. Although these differences may be small, they may lead to large changes in infant mortality figures due to the small numbers of infant deaths. There are differences between countries in legal definitions of what constitutes a live birth or a stillbirth, which affect the number of live births and infant deaths recorded (Gourbin and Masuy-Stroobant, 1995). There are also informal differences in reporting between countries, hospitals or doctors, the extent of which are difficult to measure. For example, infant deaths may be recorded as a stillbirth to remove the burden on the parents of reporting a live birth and infant death (Draper and Field, 2007). 'Cultural' differences in how very pre-term deliveries are managed may play a role, e.g. differences in whether pre-term infants are resuscitated and taken to ICU (Draper and Field, 2007). These differences may have a considerable effect on published infant mortality rates, with clear implications for the validity of cross-country comparisons.

Even when indicators are measured in the same way in different countries, different cultural contexts may affect people's responses. For example, the concepts used to measure life satisfaction can have different meanings in different cultures, and the cultural norms of where people place themselves on scales can vary. First, language and translation of terms can be a problem. Words may have different meanings or connotations in different contexts (Oishi and Schimmack, 2010). Second, the desirability of values may affect how people respond to questions, e.g. where happiness is morally valued in society, people tend to report higher scores (Ouweneel and Veenhoven, 1991). People from more individualistic cultures tend to report higher life satisfaction than people from more collectivist societies, where life satisfaction is a less valued concept (Diener and Diener, 1995). Third, there are cultural differences in response styles. It has been suggested that people from collectivist countries tend to report themselves modestly or as average citizens around the mid-point of scales (e.g. Japan), whereas people from individualistic countries tend to report their happiness in terms of their difference with others, using the extremes of the scale more (Ouweneel and Veenhoven, 1991). Finally, people who are less familiar with the concept of happiness or life satisfaction may avoid the extremes of the scale (Ouweneel and Veenhoven, 1991).

The level of income inequality may also affect our interpretation of self-reported health status or other self-reported variables. For example in more unequal countries, people may need to reassure themselves of their potential to succeed and rate themselves highly, whereas people in more equal countries may be less likely to rate themselves at the top of the scale (Barford et al., 2010).

Differences in data sources and populations

Data used to calculate measures of child health or development may be from national data sources, e.g. civil registration or hospital records, or may be from surveys. International comparisons of child health may use data from different years, in which case secular trends in the indicator should be taken into account, for example improvements in IQ over time (Rindermann, 2007).

If national data sources are used, the coverage needs to be considered. For example, civil registration of births and deaths in Europe usually covers all citizens and permanent residents. Non-nationals are usually excluded, but this is not always the case (EURO-PERISTAT project in collaboration with SCPE, 2008). This may be particularly important in countries where there are large numbers of people living temporarily or awaiting permanent residence.

If surveys are used, the sampling process (e.g. a nationally representative sample, or urban or rural) and the response rate may differ between countries. The setting of the survey should also be considered. For example, if the survey was undertaken in schools, school participation and attendance rates may differ between countries (Rindermann, 2007). As it is often children from the most disadvantaged backgrounds who do not attend school, they may not be included in the dataset. In international studies of literacy, such as PISA, the national organisers may choose to exclude some students from the study, e.g. pupils with mental retardation (Rindermann, 2007).

Differences in the population structure between countries, usually in terms of age or gender, also need to be taken into account. This is particularly important for components of child health and development that vary a great deal with age or gender, e.g. height or cognition. To compare health, independent of the age structure of the population, we can directly or indirectly standardise the data, or control for age in the analysis.

Differences in analysis

Finally, there may be differences in the way that data are analysed. For example, there may be differences in how missing data are dealt with in analysis. In some cases, adjustments may be made for differences in data collection. For example, adjustments for differences in mean pupil age are made in international literacy studies (Rindermann, 2007).

3.6. Summary of chapter 3

This chapter has reviewed the many different approaches that have been taken to measuring socioeconomic position, income inequality, health inequality and child health and development in public health research and studies on income inequality and health.

1) The different measures may influence the size of the relationship and each one has strengths and weaknesses, which are not always discussed by study authors. Particular care needs to be taken in cross country comparisons.
2) Child socioeconomic position is usually measured using parental or household measures, e.g. parental education or occupation or household income. The measurement and 'meaning' of categories may differ between countries, so care needs to be taken for cross-country comparisons.
3) A wide range of measures of health inequality have been employed, including absolute and relative measures and measures of disproportionality. The social gradient in health can be summarised in terms of the level, slope, strength, length and curvilinearity. In this thesis I am particularly interested in the level and slope.
4) Social and economic inequality is most frequently measured using income inequality (which can also be seen as a proxy for broader inequality in society). A number of measures are available, of which the Gini is particularly widely used. Recent initiatives such as the SWIID have developed comparable figures on income inequality between countries and over time.
5) There are numerous ways to measure child health and development. I have divided indicators into the following domains: physical health and development, socio-emotional development and behaviour, cognitive development. Differences in measurement and meaning of variables between countries need to be taken into account in comparisons.
6) There is no single 'best' indicator or index for measuring SEP, inequality or health and development and conducting cross-country comparisons. However consideration of the strengths and weaknesses can inform the choice of indicators for comparative analysis (chapter 5) and the interpretation of findings (chapters 4, 8 and 9).

Chapter 4: Critical review of studies that have compared the social gradient in health and wellbeing in more and less equal societies

This chapter provides a critical review of studies that have compared the social gradient in health/development/wellbeing in societies with different levels of income inequality. I start with an introduction and present alternative models for how social gradients relate to income inequality. I then provide an overview of methods used, including the search strategy and my approach to presentation of findings. The findings are presented in the order of the three domains of health/development: physical health and wellbeing, socio-emotional wellbeing and behaviour, and cognitive development/educational achievement. Findings from included studies are used to assess the evidence for each model of social gradients in relation to income inequality.

4.1. Introduction

This chapter reviews studies that have compared the social gradient in health or wellbeing in societies with different levels of inequality. Not all studies have considered the role of income inequality; where this is the case I have analysed data from studies in relation to data on income inequality and presented findings in graphs. As few studies have focused on child health and development, I have included studies on adult health and wellbeing in the review. The colour coding system is used throughout this chapter: light blue indicates less income equality and dark blue indicates more income inequality in each graph.

Objectives and research questions

The critical review will achieve overall objective 2: *To review studies that have compared the social gradient in health and wellbeing between high income societies with different levels of income inequality*

Specific objectives for the critical review:

i. To summarise and appraise evidence from studies that have described and analysed social gradients in health, development or wellbeing in different societies/countries
ii. To analyse differences in social gradients in relation to income inequality using additional income inequality data where necessary

This review and analysis will help to answer my three research questions on features of the social gradient in health and development:

- How does the *slope* of the social gradient vary in relation to income inequality? (Is the gradient steeper in more unequal countries?)
- How does the *level* of the social gradient vary in relation to income inequality? (Is health worse overall in more unequal countries?)
- *Does everyone do better in more equal countries*? (comparing both the slope and level of the gradient)

I also consider the *strength* of the association. This information is not available in all studies, but where it is the strength will be considered. A strong association suggests less residual confounding by other factors, but is also affected by sample size and study power.

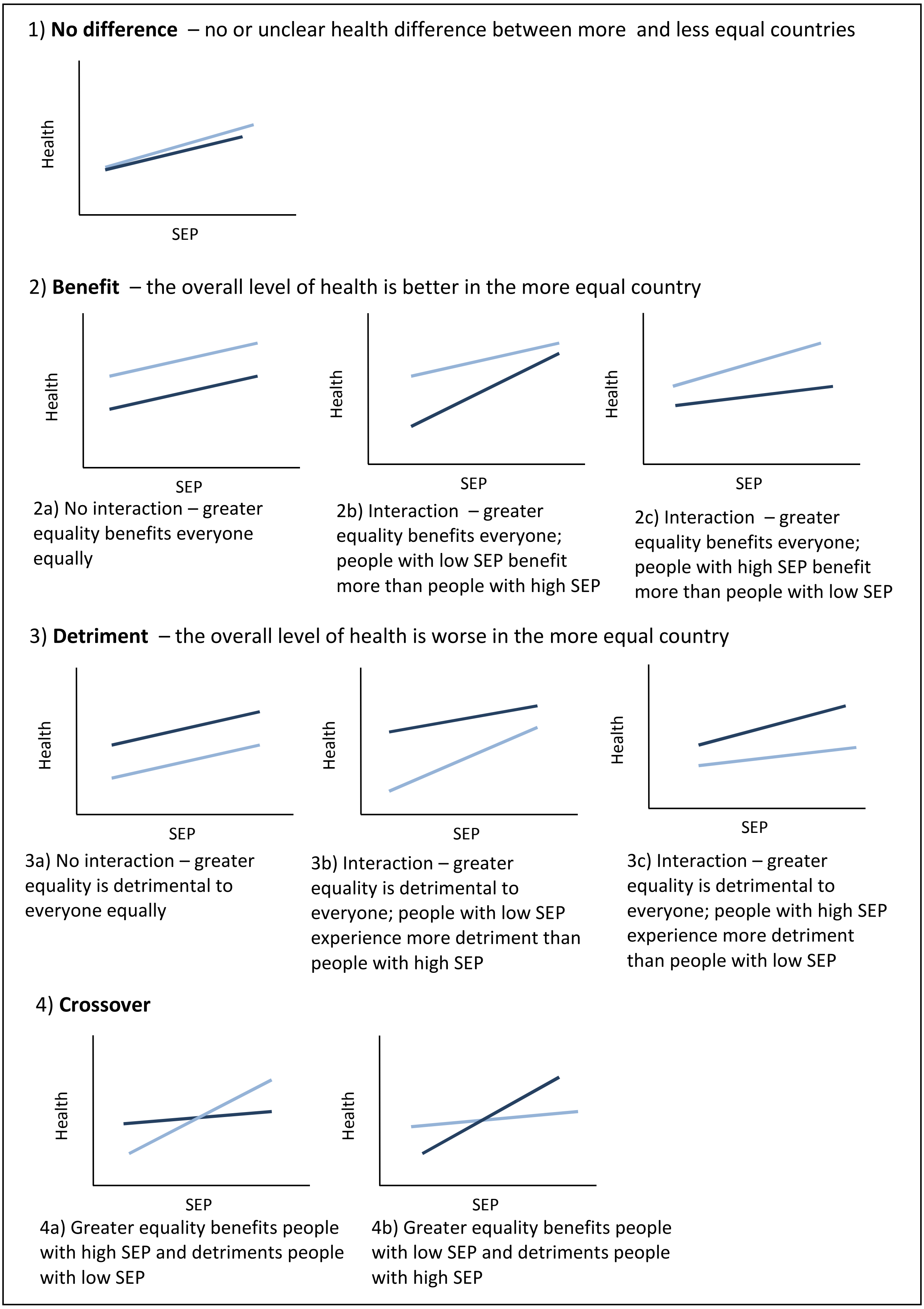
Models of the social gradient in relation to inequality

There are four possible scenarios for the relationship between income inequality and the social gradient (shown in Figure 4-1).

1) There may be **no difference (model 1)**, with no benefit or unclear or inconsistent differences in the level of health and social gradient in more equal countries, compared with less equal societies.
2) There may be **benefit (model 2)** for people living in more equal countries. There are three different possible types of benefit. Benefit could be shared across society, such that all social groups benefit equally. Alternatively, there could be interaction, such that the benefit is greatest among the poor or among the rich in more equal countries.
3) There may be **detriment (model 3)** to health in more equal countries. As with the benefit model, there are three subtypes. There may be equal detriment for all socioeconomic groups, or greater equality may be more detrimental for either the high or low socioeconomic groups.
4) There may be a **crossover (model 4)** effect. In this scenario, there is interaction, such that inequality has different effects for different socioeconomic groups. For example, there

may be a benefit to people at low socioeconomic positions and detriment to people at high socioeconomic positions, or vice-versa.

Figure 4-1: Four models of the relationship between income inequality and the social gradient



4.2. Methods

Literature search

Search strategy

I searched electronic databases for published studies and online search engines for unpublished studies. The following databases were searched:

- Medline (Ovid)
- Google Scholar

Search terms focussed on the predictor variables (income inequality and socioeconomic position) and methods. I did not search for specific outcomes as I am interested in a wide range of health and development outcomes. Combinations of the following search terms were used:

- Inequalit*
- Gini
- Gradient
- Socio*economic
- Health
- Development
- Well*being
- Interaction
- Comparison

There were three key challenges to the literature search. First, literature on health and development crosses many disciplines, including public health, economics, education, sociology and social policy, psychology. This meant that it was difficult to ensure that the search did not miss key literature from different disciplines.

Second, the search terms yielded very large numbers of articles and it was difficult to focus them down further. It was difficult to search for studies that have studied both social gradients and inequality in relation to health/development, for example using the terms 'inequality' AND 'socioeconomic' yielded papers that have studied socioeconomic inequalities, rather than the interaction between the terms.

Third, some of the studies that have reported the social gradient in health or development in more and less equal societies have not set objectives to analyse this relationship or the interaction between socioeconomic position and income inequality. Therefore these studies may not have been picked up by the search terms.

As a result of these issues, searching databases was not an effective means of identifying literature. I therefore also scanned the reference lists of studies that I had initially identified. After identifying which studies would be included, I also conducted a search for studies that have cited the included studies. These methods proved to be more successful for identifying relevant papers.

Inclusion and exclusion criteria

I used the following inclusion criteria for the review:

1) Population and sample: I included studies that have compared two or more societies (countries or large areas, e.g. states). Studies could focus on children or adults.
2) Exposure: I was interested in both socioeconomic position and income inequality. I included only studies with three or more categories of socioeconomic position – i.e. studies that have looked at the gradient across society, rather than the difference between rich and poor. Few studies described or analysed the role of income inequality in explaining individual level health or the social gradient. Therefore, I also included studies that did not describe or analyse income inequality and identified statistics on income inequality from other sources (described further below).
3) Outcome: I included studies with any health or wellbeing outcomes, including physical, socio-emotional and cognitive outcomes.
4) Study type and analysis methods:
    - I included individual level and ecological studies.
    - I included studies that reported the absolute level of health for different socioeconomic groups. This enabled me to compare the slope and level of the gradient. These studies usually reported absolute measures of inequality, e.g. rate differences; studies using relative measures of inequality were included only if the absolute level of health/wellbeing in different socioeconomic groups was also reported. Some studies used regression models – these were included when absolute predicted (from the model) health for different socioeconomic groups were included. I also included studies that had analysed both the slope (e.g. using SII) and level of the gradient.
5) Publication type: I included published articles and unpublished, grey literature.

I excluded studies that focussed only on low or middle income countries, in line with the focus of my thesis on high income countries.

I excluded studies that had compared the social gradient using different outcomes. If studies had used some comparable outcomes they were included, however studies that used different outcomes, e.g. very different measures of cognition in each society, were excluded.

I identified few studies that described or analysed the social gradient in relation to inequality in small areas (e.g. counties). I was unable to identify income inequality statistics for these small areas and therefore could not conduct comparisons in relation to income inequality. I therefore excluded these studies.

I excluded studies that only compared health inequalities using relative measures (e.g. rate ratios or prevalence ratios) or using single indices that summarise relative differences (e.g. Relative index of inequality), with no absolute figures. Whilst these studies allow us to compare the relative differences between socioeconomic groups, without information on absolute levels it is not possible to compare the slope or level of the social gradient. As an example, if two countries have the same relative inequality in prevalence of a health condition, the level of absolute inequality would be higher and the social gradient steeper in the country with higher prevalence of the condition. It is not possible to assess this from prevalence alone. As discussed in chapter 3, this issue has created controversy in international rankings of health inequality, with regard to Scandinavian countries, which have been shown to have large relative inequalities, yet low absolute inequalities due to low rates of ill health (Moser et al., 2007).

Summarising and presenting findings

I extracted information from each study in tables, in order to compare methods used and findings (see summary table of findings in Appendix 4).

Categorisation by study outcomes

The included studies used a wide range of methods, samples and outcome measures. I categorised studies and structured the review by the outcome measures presented. This was useful to summarise and compare the study findings on each of the three categories of child health and development (explained in chapter 3). Where studies had compared more than one outcome, I included them in all the relevant categories. The groups are:

1. Physical health
    a. Mortality
    b. Morbidity (objectively measured)
    c. Morbidity (subjectively reported)
2. Socio-emotional wellbeing and behaviour
3. Cognitive development and educational achievement

Analytic methods and interpretation

Studies also used a range of analytic methods to compare social gradients. Some employed absolute risk differences between socioeconomic groups. These studies presented prevalence or rates or mean scores by socioeconomic position (3 or more groups). Others employed single indices or coefficients which measure absolute inequality across the whole socioeconomic spectrum, e.g. the Slope Index of Inequality, together with data on the level of the gradient.

I presented findings from studies using a range of analysis methods within each health and development category. I included comparison of the slope and the level, and assessed which of the models presented in Figure 4-1 the findings fit.

Extracting and visualising data

I extracted data from the studies using tables. Where absolute and relative measures were available using the same data, I reported only absolute measures. Where possible, I used figures that had only adjusted for age, in order to aid comparability (as studies had adjusted for different confounders).

In order to compare the social gradient by the level of income inequality, I included the Gini coefficient in each table. I used the Gini coefficients presented in the study, when the authors had described or analysed income inequality. Where the authors had not presented the Gini coefficient, I identified it from another source. Where publications had used the same data source as another publication, which did report the Gini coefficient, I used the same source. For example, several articles used data from Health Behaviour in School age Children study (HBSC), one of which had also reported Gini coefficients – I used these for all articles reporting data from HBSC, in order to maintain consistency. For other studies, I used Gini coefficients from the SWIID database.

I then used the data to draw graphs in order to provide a visual comparison of the social gradients in health/wellbeing/development between countries. In each graph I have used the colour coding scheme for the lines or bars, according to the Gini coefficient in the country. The lighter the shade of blue, the lower the Gini coefficient and more equal the country (e.g. the US is shaded a darker blue than the UK, which is more equal). Colour coding was applied relative to other countries in each particular graph. In some of the studies, the data were not provided in the publication, so I was not able to draw graphs. If graphs were presented in the publications I have included these, however I was not able to colour code these.

I conducted qualitative comparisons of the social gradients by comparing the graphs. Due to the heterogeneity of studies in terms of study design and countries, exposure, outcome and analysis methods, it was not possible to conduct any pooled statistical analysis.

4.3. Findings

Description of included studies

In total, I identified 13 papers that compared the social gradient in health/wellbeing/development across countries. Table 4-1 gives an overview of the studies and the outcomes measured. Further detail on the characteristics and methods of each study is provided in Appendix 4.

Nearly all the studies made national-level comparisons. I identified one study which compared large geographic areas (US states) in relation to income inequality. All of the studies compared high income countries, although several studies also included some middle income countries.

There were broadly two types of studies:

1) Studies which compared data from separate surveys and data sources.
   These studies tended to compare a small number of countries. Most of these studies presented descriptions of the social gradients in the study countries using absolute risk differences. Some included qualitative comparisons of the role of income inequality.
2) Studies which used large, international surveys.
   These studies tended to compare a large number of countries. This has the advantage that outcomes and exposures have been measured and categorised in the same way (although there may still be differences in context, culture and response). These studies mostly used regression models and some analysed the role of income inequality.

Table 4-1: Summary of included studies and outcomes measured

Reference	Outcomes				
	Physical wellbeing and health			Socio-emotional wellbeing and behaviour	Cognition and education
	Mortality	Morbidity – objectively measured	Morbidity – subjectively reported		
(Leon et al., 1992)	Neonatal and post neonatal mortality				
(Vagerö and Lundberg, 1989)	All-cause mortality				
(Wilkinson and Pickett, 2008)	Mortality (10 causes)				
(Banks et al., 2006a) (Banks et al., 2006b)		Diabetes Hypertension C-reactive protein Fibrinogen HDL cholesterol	Diabetes, Hypertension Heart disease and myocardial infarction Stroke Lung disease Cancer	Self-reported health behaviours (smoking)	
(Adler et al., 2008)		Hypertension	Global health	Depression	
(Lahelma et al., 1994)			Limiting long-standing illness		
(Due et al., 2009a)			BMI (height and weight)		
(Levin et al., 2010)				Life satisfaction	
(Marks, 2005)					Reading literacy
(Bradbury et al., 2010)				Hyperactivity /inattention and conduct problems	Vocabulary
(OECD, 2010)					Reading literacy
(OECD and Statistics Canada, 2000)					Prose, Document, Quantitative literacy

Physical wellbeing and health

Mortality

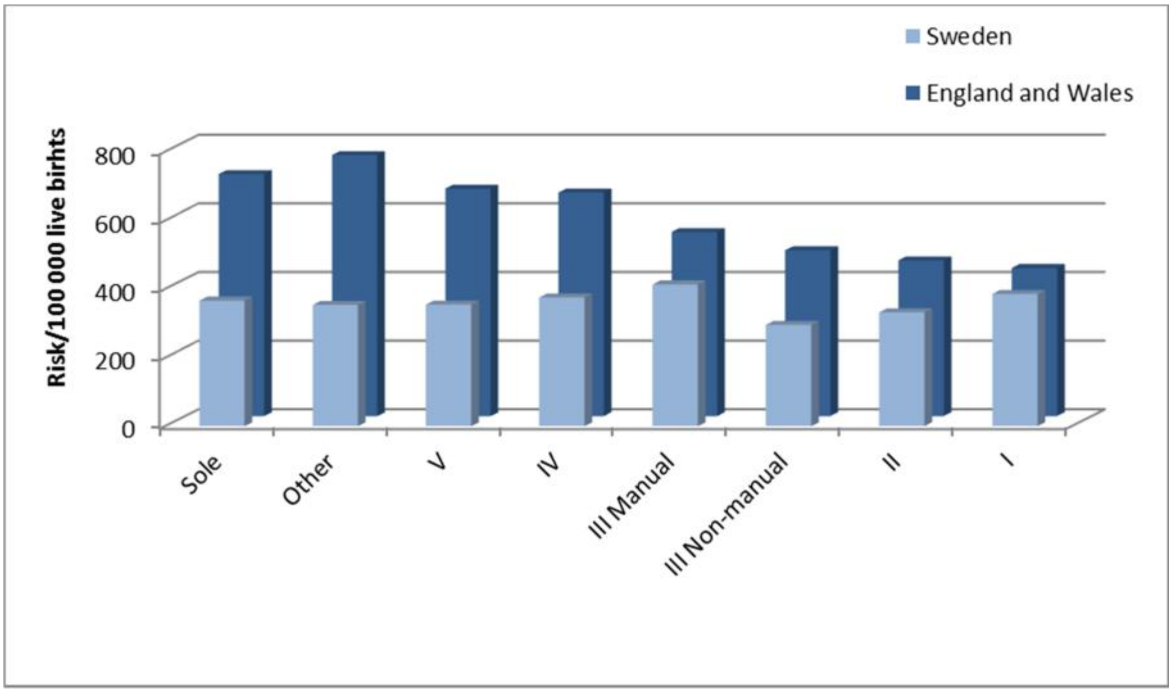
There were three studies which compared the social gradient in mortality. Two of these used individual/household data and measures of occupational status; one was an ecological study using county-level data and median income as the measure of socioeconomic position.

Two of the comparisons of mortality compared Sweden with Britain or England and Wales. Neither of these studies analysed the role of income inequality. Leon and colleagues compared the social gradients in neonatal and post neonatal mortality (Leon et al., 1992) (Figure 4-2 and Figure 4-3). They classified infant deaths by father's occupation. Given international differences in the way that infant deaths are classified (Kramer et al., 2002, Gourbin and Masuy-Stroobant, 1995), post neonatal mortality measurement may be a more consistent measure for comparisons. Vagerö and Lundberg compared the social gradient in age-standardised death rates among men aged 20-64 (Vagerö and Lundberg, 1989) (Figure 4-4).

Both studies applied the British Registrar General Scheme of social class to categorise occupation in both countries for comparison. There were differences in the proportion of the population or live births in each social class category between countries. At the time of data collection for both studies, Sweden had a lower Gini coefficient (Sweden 0.215, UK 0.268 in LIS 1974/5; Sweden 0.197, UK 0.270 in LIS wave 1), however neither study analysed the role of income inequality.

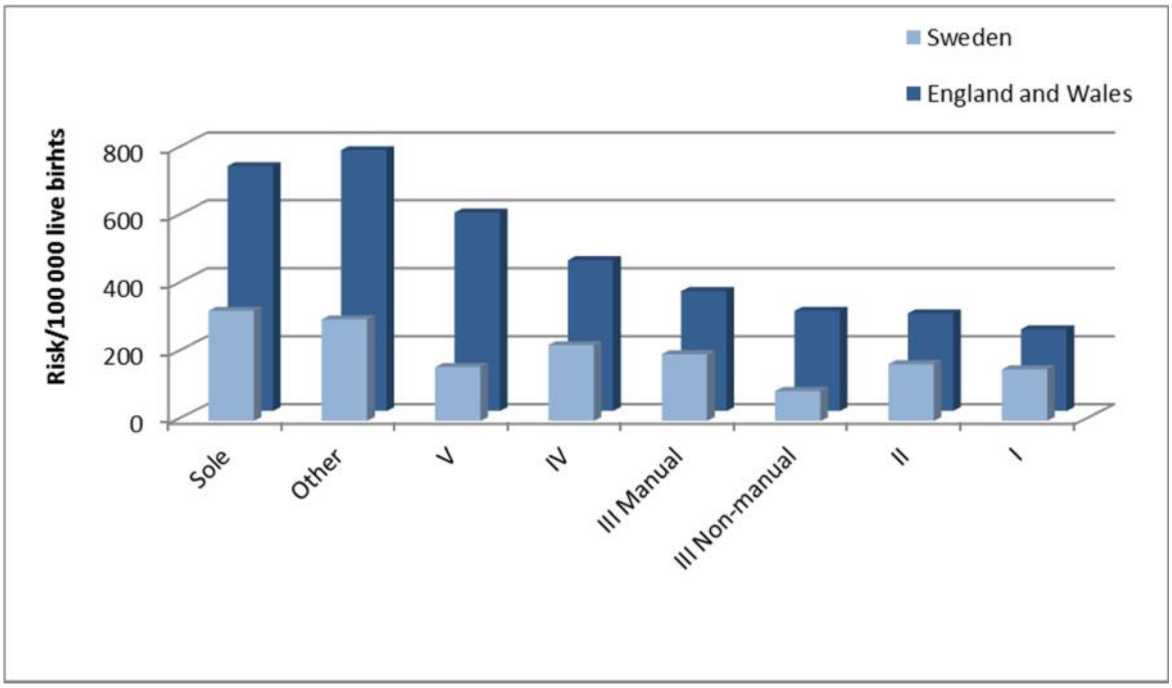
Both of these studies show that mortality rates were lower overall in more equal Sweden. The social gradient in death rates was shallower in Sweden, i.e. death rates were lower among all social classes in Sweden: they were considerably lower among low occupation groups, but also lower among higher occupational groups. Both studies therefore support model 2b)

Figure 4-2: Neonatal mortality in Sweden (1985-6) and England and Wales (1983-5) by social class



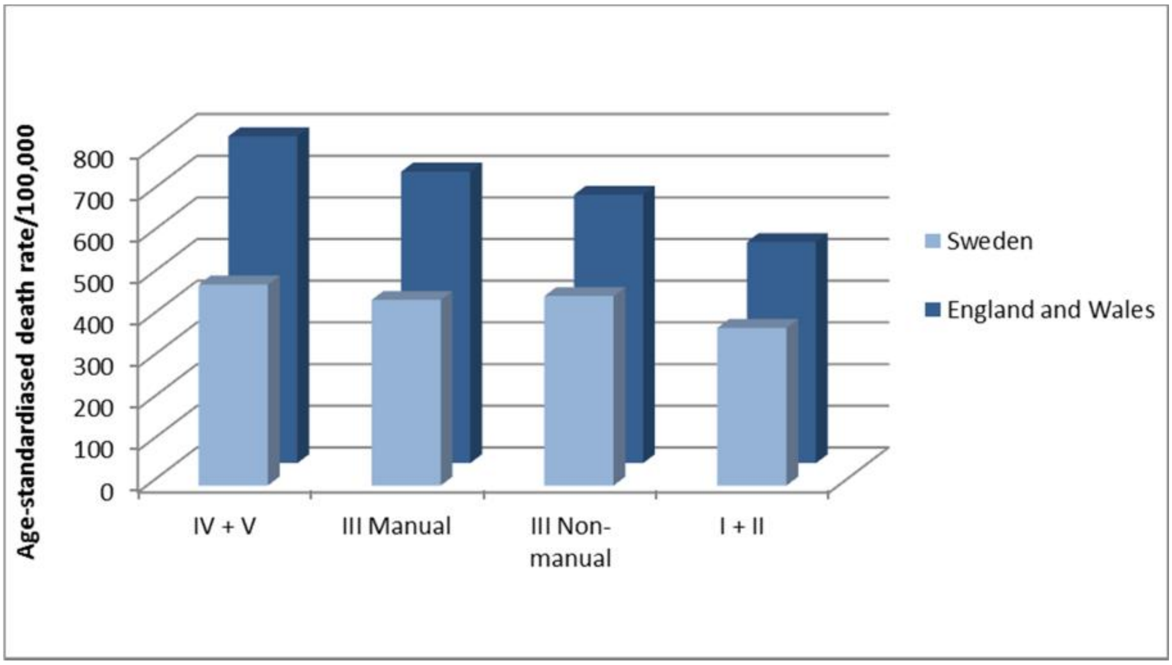
Source: graph drawn from data in (Leon et al., 1992)

Figure 4-3: Post neonatal mortality in Sweden (1985-6) and England and Wales (1983-5) by social class



Source: graph drawn from data in (Leon et al., 1992)

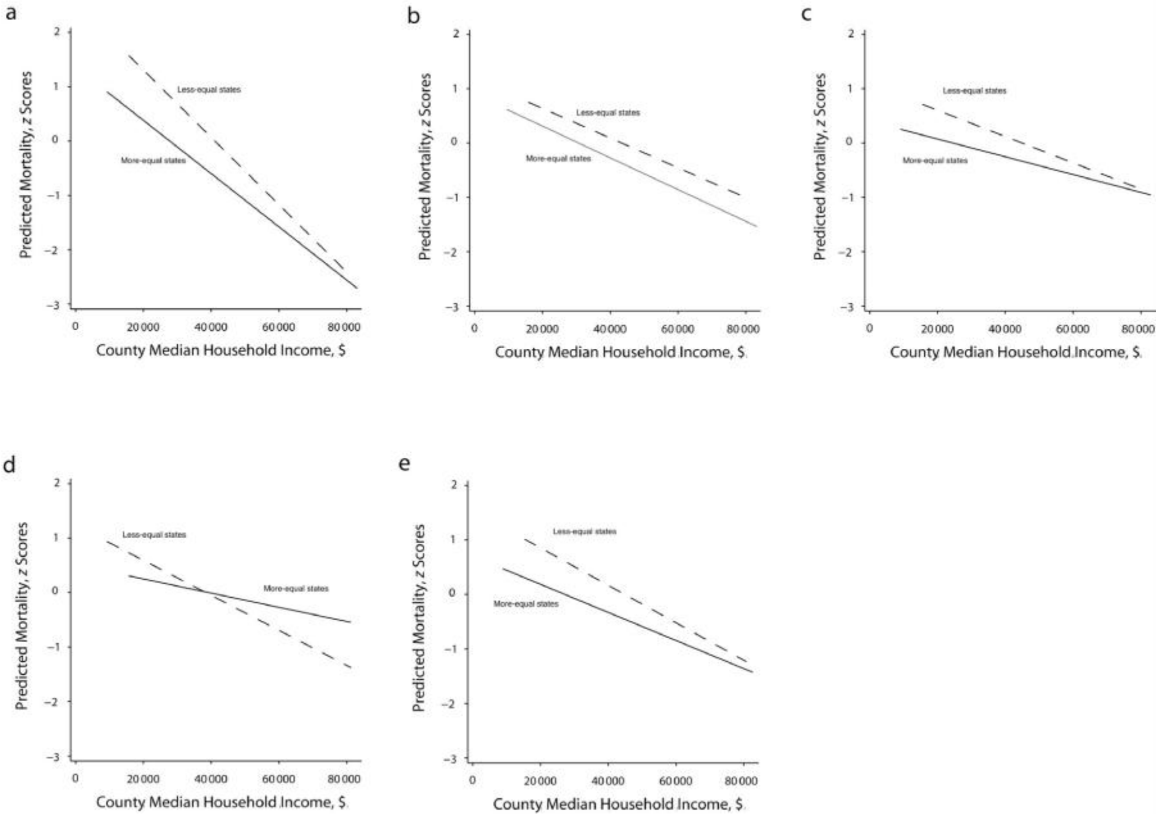
Figure 4-4: Death rates by social class for men aged 20-64 in England and Wales (1970-72) and Sweden (1961-79)



Source: graph drawn from data in (Vagerö and Lundberg, 1989)

Wilkinson and Pickett (2008) compared the county-level social gradients in mortality (for 10 different causes of mortality) in US states, in relation to state-level income inequality. The study used county-level mortality rates and county-level median income to measure socioeconomic mortality gradients (rather than individual or household data). The authors categorised the states into 2 equal groups of high and low inequality states and employed multi-level models to test for cross-level interaction between the categories of state-level income inequality and county level income in relation to county mortality. The findings differed by cause of death. They found statistically significant interactions for 5 of the 10 causes of mortality. Figure 4-5 shows graphs of the social gradients by county-level household income in more and less equal states for the causes of death with statistically significant interactions. The comparisons of gradients in 3 causes of mortality (all-cause mortality among those of working age, respiratory disease and homicide) show that the level of mortality is lower and the gradient is shallower in more equal states, supporting model 2b (benefit with interaction). The findings for ischemic heart disease support model 2a (benefit, no interaction) and findings for alcoholic liver disease support model 4b (crossover), such that more equal states had lower mortality in poorer counties, but higher mortality in wealthier counties. The findings for the other 5 causes of death (all-cause mortality (age 65+), infant mortality, diabetes, prostate cancer, breast cancer) did not have significant interactions, so support model 1 (no difference). Overall, causes of mortality that were more strongly related to county median income (i.e. had a steep social gradient) were more likely to be associated with income inequality.

Figure 4-5: Mortality gradients by mean county household income in more and less equal states*



* mortality z scores for:

a) all-cause mortality among those of working age (25-64 years); b) ischemic heart disease; c) respiratory disease; d) alcoholic liver disease; e) homicide

In summary, two of the mortality studies fully supported model 2b, i.e. benefit in more equal countries, with greater benefit for those at the bottom of the social hierarchy. The third study partially supported this model, although there were differences by outcome. There was also evidence for model 1 (no difference), model 2a (benefit with no interaction) and model 4 (cross-over).

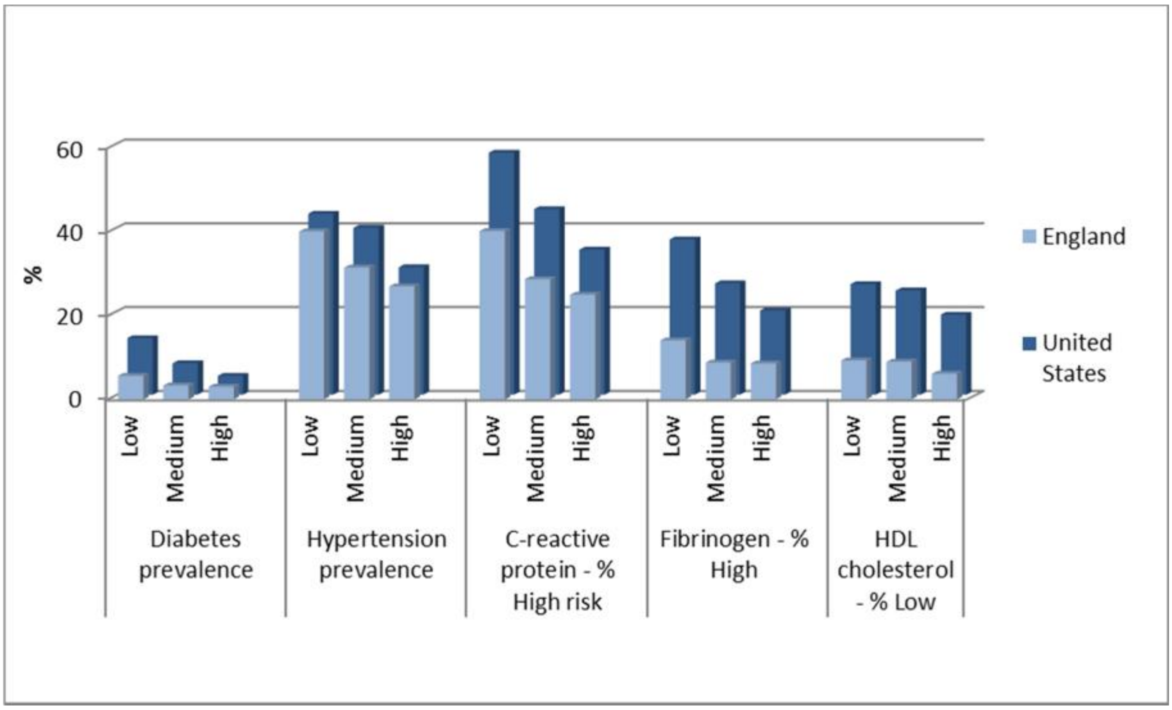
Morbidity – objectively measured

There were only two studies that compared the social gradient in morbidity using objectively measured data. Both studies compared the US and the UK or England and neither analysed the role of income inequality. The studies used data collected between 1997-2003. Using LIS wave 5 data (1999-2000) the UK was slightly more equal (0.347) than the US (0.368).

Banks and colleagues analysed the social gradient in biological measures of health among 40-70 year old white men in the US and England (as well as self-reported health and risk behaviours, reported below). The findings have been published in two separate reports, which I have grouped together (Banks et al., 2006a, Banks et al., 2006b) (I have reported statistics from (Banks et al., 2006b)). Data were compiled from nationally representative surveys between 1999 and 2003 and included measures of diabetes, hypertension, c-reactive protein, fibrinogen and HDL cholesterol levels. SEP was measured using education achievement and income, each of which were categorised into 3 groups.

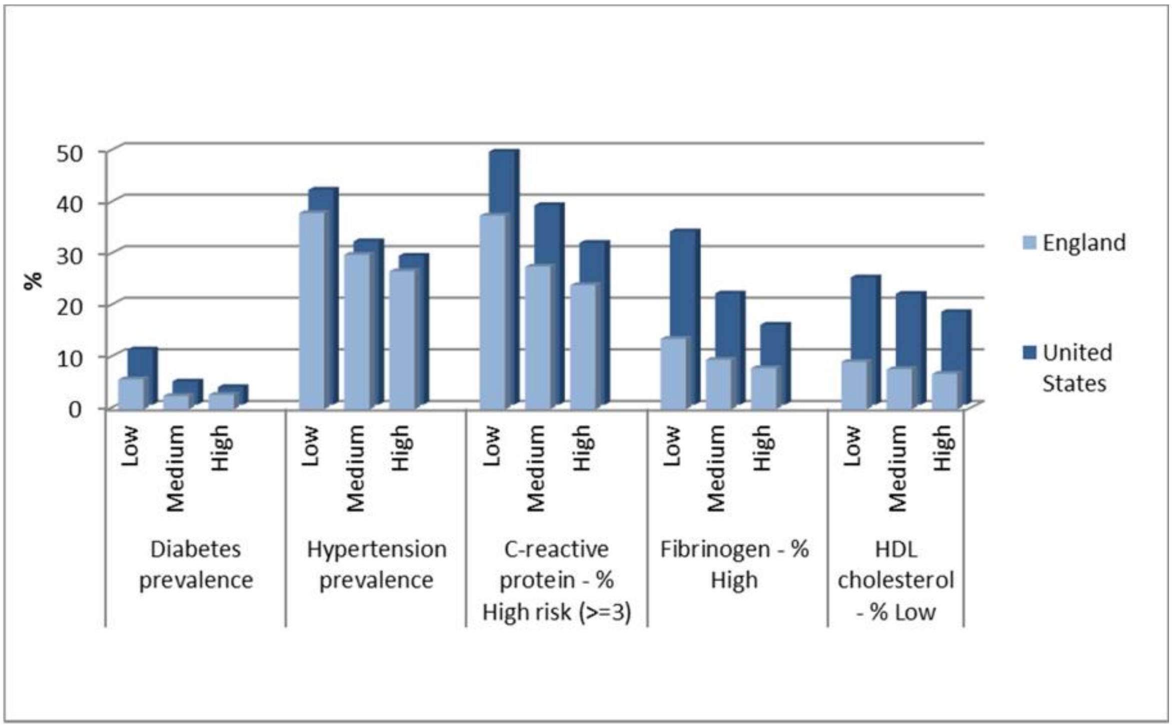
The social gradients in the US and England are shown in Figure 4-6 and Figure 4-7. For C-reactive protein, fibrinogen and HDL cholesterol I have shown the percentage in the high risk group in each SEP category. Morbidity was lower in the UK, the more equal country, than the US for all objectively measured outcomes. The social gradient was also shallower in the UK for diabetes, high risk c-reactive protein, high risk fibrinogen and high risk (low) HDL, for both measures of SEP. This supports model 2b. There appears to be little difference in the social gradient for hypertension prevalence (2a).

Figure 4-6: Laboratory biomarkers of disease and disease risk by education group, ages 40-70, in the United States (1999-2002) and England (2003)



Source: graph drawn using data from (Banks et al., 2006b)

Figure 4-7: Laboratory bio-markers of disease and disease risk by income group, ages 40-70, in the United States (1999-2002) and England (2003)

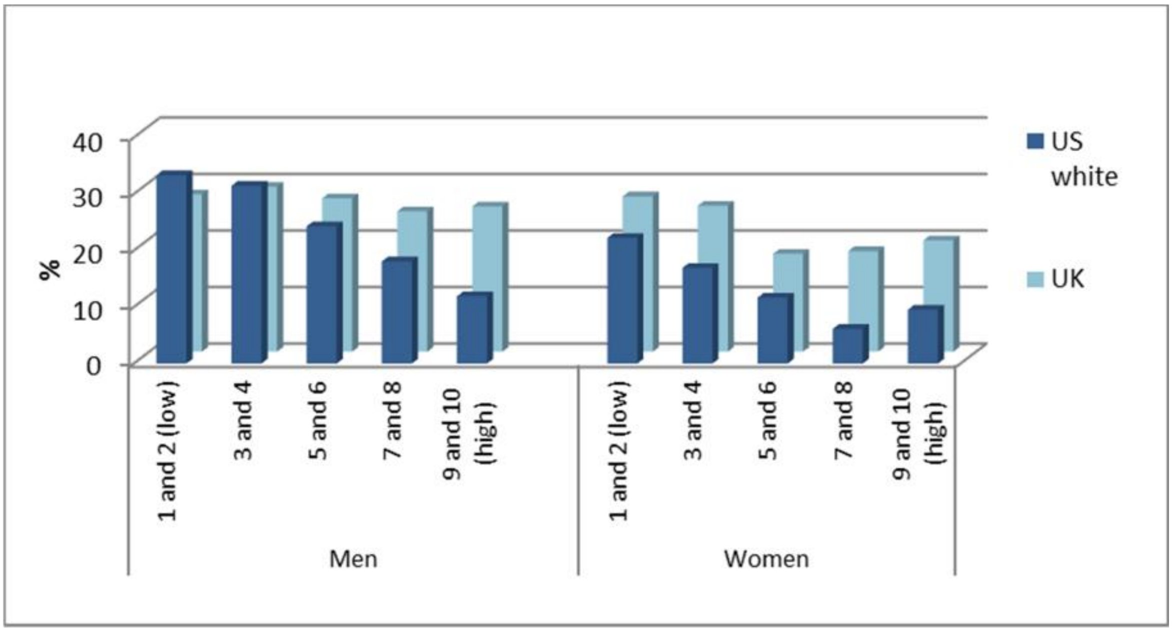


Source: graph drawn using data from (Banks et al., 2006b)

Adler and colleagues compared the social gradient in objectively measured hypertension using two cohort studies from the US and the UK (Adler et al., 2008). The Whitehall-II study in the UK followed up civil servants aged 33-48; and CARDIA in the US included people aged 47-67 from both community samples and samples from health plans. The two cohorts therefore had different sample characteristics, in terms of the age range (the US cohort was younger), the type and range of occupation and income and time of data collection. They analysed the white and black samples in CARDIA separately. The study used Subjective Social Status as the measure of SEP.

I have graphed the comparisons of the UK civil servants and the US white sample. I have excluded the US black sample, in order to compare more similar samples between two countries. Adler's findings differ from the Banks study. Hypertension rates were higher overall in the UK, which is more equal than the US. There was little difference in the social gradient for women, although it appears slightly steeper in the US (model 3b). For men, there was evidence of crossover (model 4), with higher rates of hypertension among people with low SSS among the US white men, and higher rates at high SSS among UK men.

Figure 4-8: Age-adjusted prevalence of hypertension by subjective social status, US and UK, 1997-2001



Source: graph drawn using data from (Adler et al., 2008)

In summary, there was not clear evidence in support of any particular model from studies of objectively measured morbidity. The differences may have been in part due to different approaches to measuring SEP. When SEP was measured using traditional measures (occupation and education), findings supported models 2a and 2b. However, in the study using subjective social status, findings supported models 3b and 4a.

Morbidity – subjectively-reported

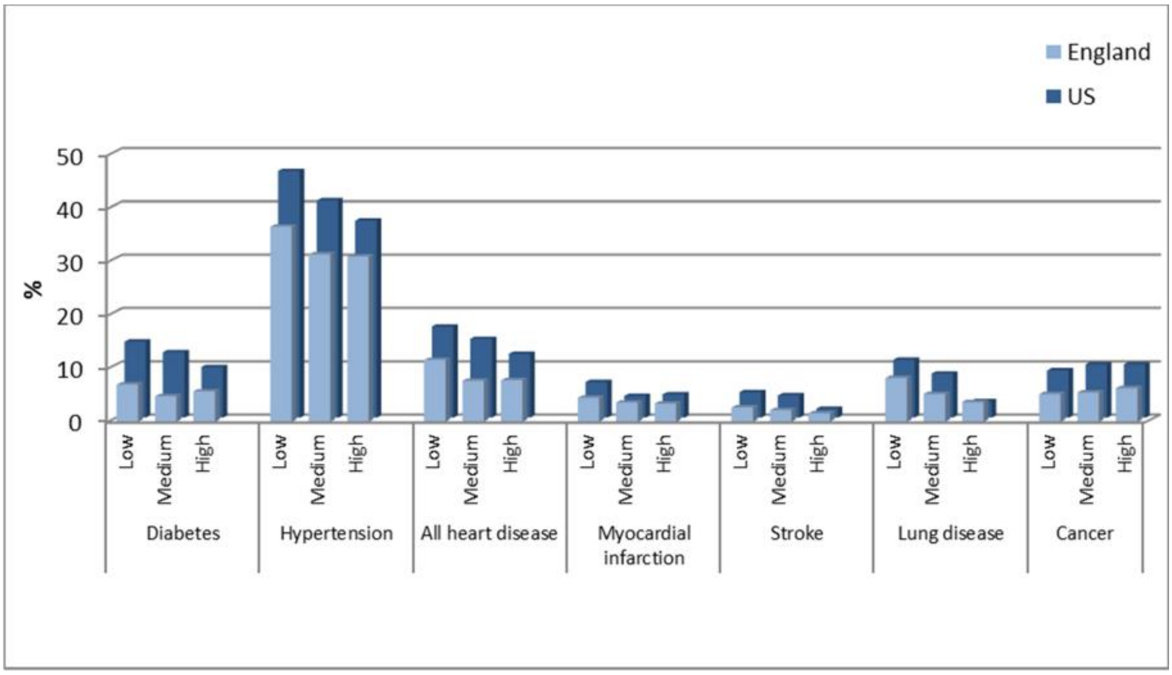
Four studies compared subjectively-reported morbidity. Two of the studies compared the United States and the United Kingdom or England (Adler et al., 2008, Banks et al., 2006a, Banks et al., 2006b). One compared Scandinavian countries and one compared 33 countries in Europe and America. The studies measured a wide range of types of morbidity and employed a range of measures of SEP. Only one of these studies (Due et al., 2009a) analysed the role of income inequality.

The two studies that compared the US and the UK or England were described above (Adler et al., 2008, Banks et al., 2006a, Banks et al., 2006b). Banks and colleagues analysed the social gradient in self-reported chronic diseases among white men by education and household income. There is limited information on differences in wording of the self-report questions, although the authors state that risk factors were measured comparably.

Banks and colleagues found that rates of self-reported chronic diseases were generally higher and the gradient was steeper in the US, which is more unequal than the UK (Figure 4-9 and Figure 4-10). This was true for both education and income gradients and for self-reported diabetes, hypertension, all heart disease, myocardial infarction, stroke and lung disease. In other words, self-reported health is better for everyone in the UK than in the US: it is considerably better among the low socioeconomic group, but people in the high socioeconomic group also have better self-reported health in England (model 2b). There was one exception to this pattern. Self-reported cancer rates were higher in the US, but there was no clear social gradient in either country, and no clear difference in social gradient (model 2a).

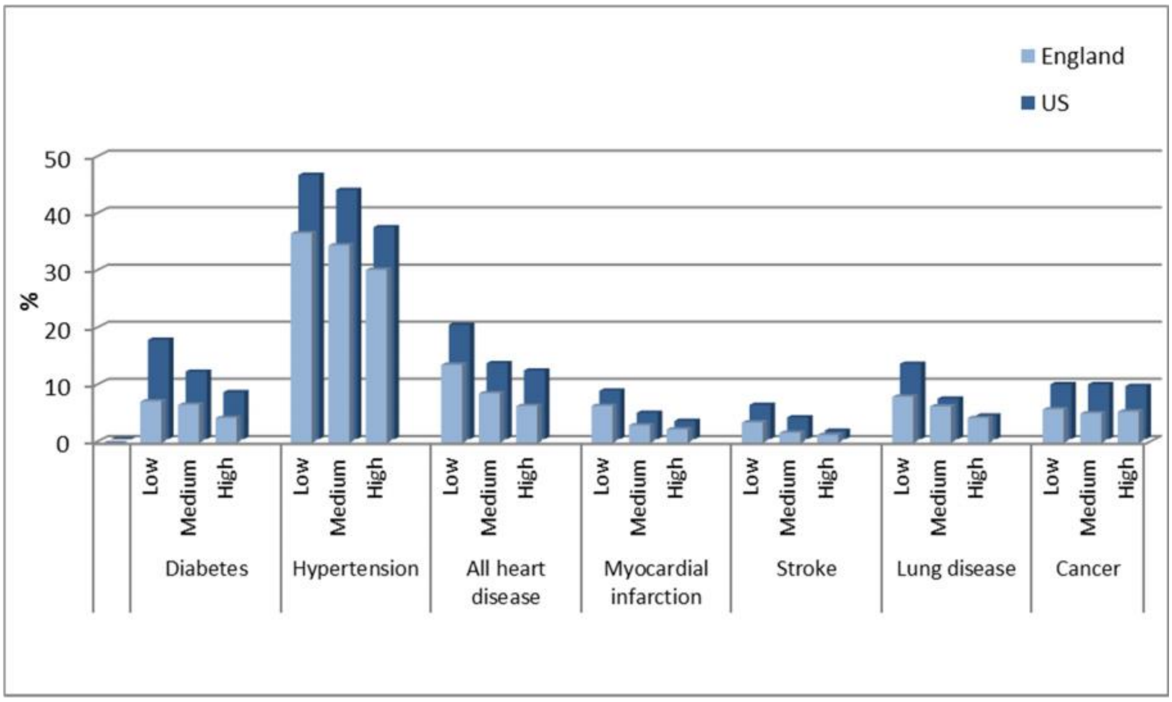
Banks and colleagues had mixed findings on obesity and overweight prevalence (Figure 4-11). Rates of obesity were higher and the gradient was steeper in the US (model 2a). However, rates of overweight were higher in the UK, with small and inconsistent differences in the steepness of the positive gradient (i.e. people with high socioeconomic status do worse in both countries; there is detriment for everyone in the more equal country) (model 3a).

Figure 4-9: Prevalence of self-reported chronic illness by education group in England and the United States, ages 55-64, 2002



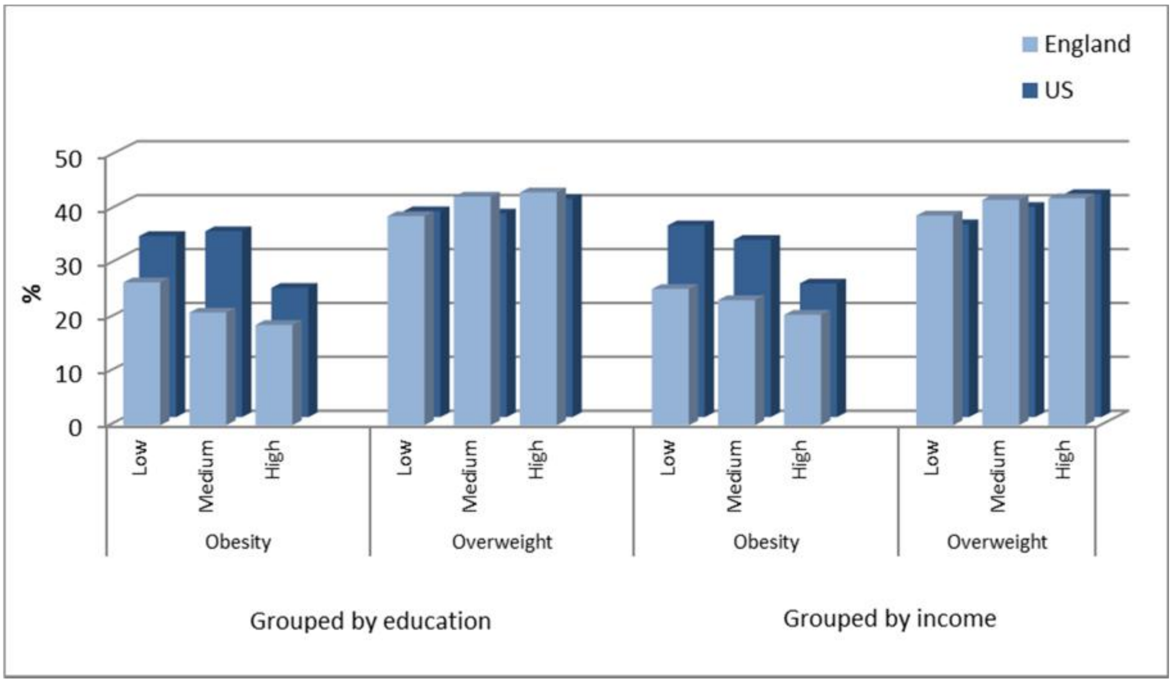
Source: graph drawn using data from (Banks et al., 2006b)

Figure 4-10: Prevalence of self-reported chronic illness by income group in England and the United States, ages 55-64, 2002



Source: graph drawn using data from (Banks et al., 2006b)

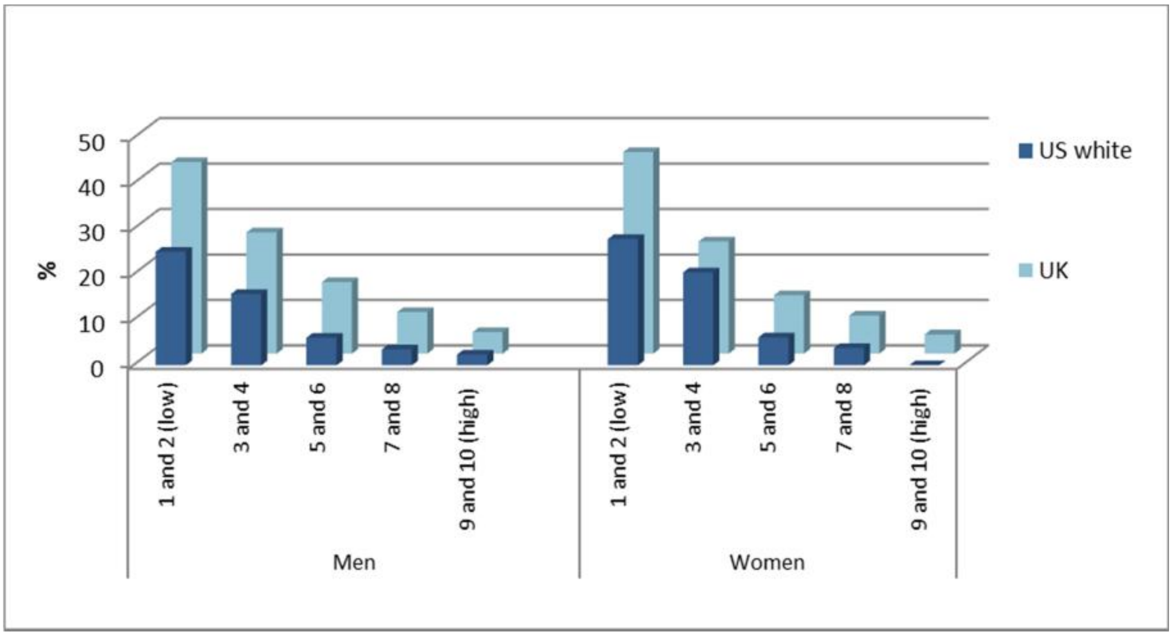
Figure 4-11: Prevalence of self-reported obesity and overweight by income and education group in England and the United States, ages 55-64, 2002



Source: graph drawn using data from (Banks et al., 2006b)

Adler and colleagues analysed the gradient in self-reported health by subjective social status using two cohort studies, as described above (Adler et al., 2008). There were some differences in wording of the question in the two studies, as well as other differences noted above. Figure 4-12 shows the proportion who reported fair or poor health in the US white and the UK samples. The percentage who reported fair or poor health was higher in the UK (more equal) for nearly all socioeconomic groups and the gradient was slightly steeper. This supports model 3b everyone has worse health in the UK, people with low socioeconomic position have the greatest detriment. As above, gradients were reported by subjective socioeconomic status.

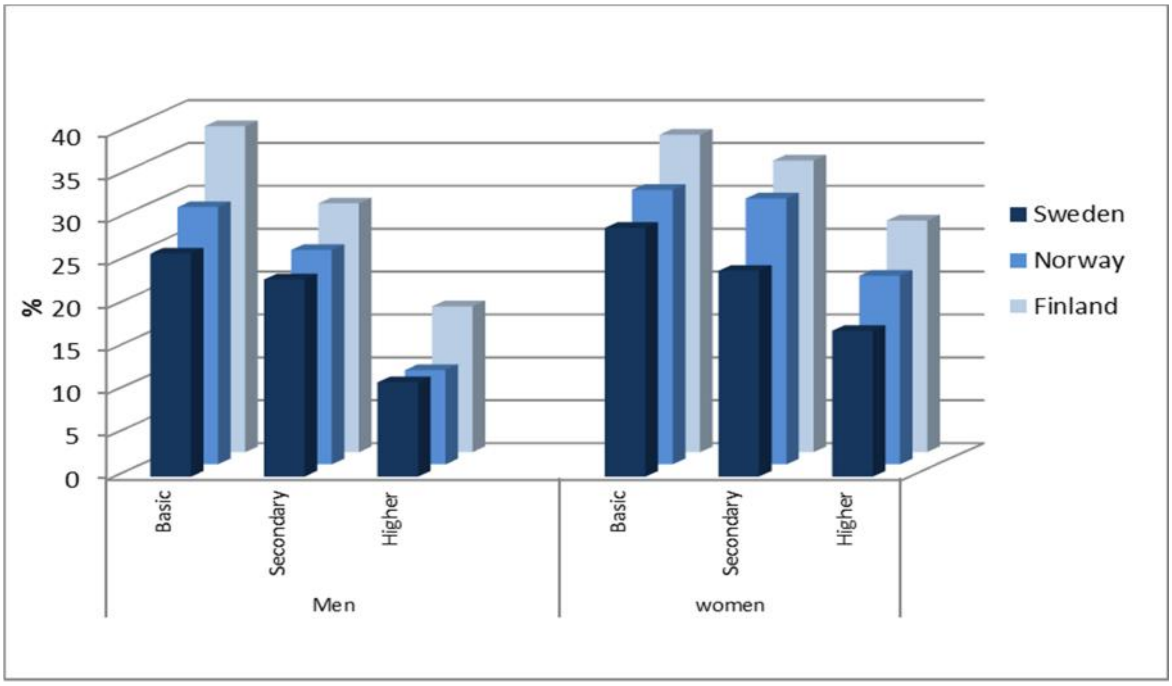
Figure 4-12: Age-adjusted prevalence of self-reported fair/poor health, by subjective social status, US and UK



Source: graph drawn using data from (Adler et al., 2008)

The third study compared rates of self-reported limiting long-standing illness among 25-74 year olds in Finland, Sweden and Norway (Lahelma et al., 1994). This study used the Level of Living Surveys, which were designed collaboratively, to aid comparability between the countries. The authors compared the prevalence of illness by education level. At the time of data collection, differences in income inequality were small, although Finland was most equal, followed by Sweden, then Norway (Gini coefficients were: Sweden 0.218, Norway 0.233, Finland 0.209 (LIS, wave II)). The role of income inequality was not analysed. In this study there was little difference in the social gradient between the three countries Figure 4-13 (which may reflect the small differences in income inequality). However, the prevalence of limiting long-standing illness was highest in Finland, the most equal country, supporting model 3a.

Figure 4-13: Age-standardised percentages of limiting long-standing illness by education level, ages 25-74, Finland, Norway and Sweden, 1986/7



Source: graph drawn using data in (Lahelma et al., 1994)

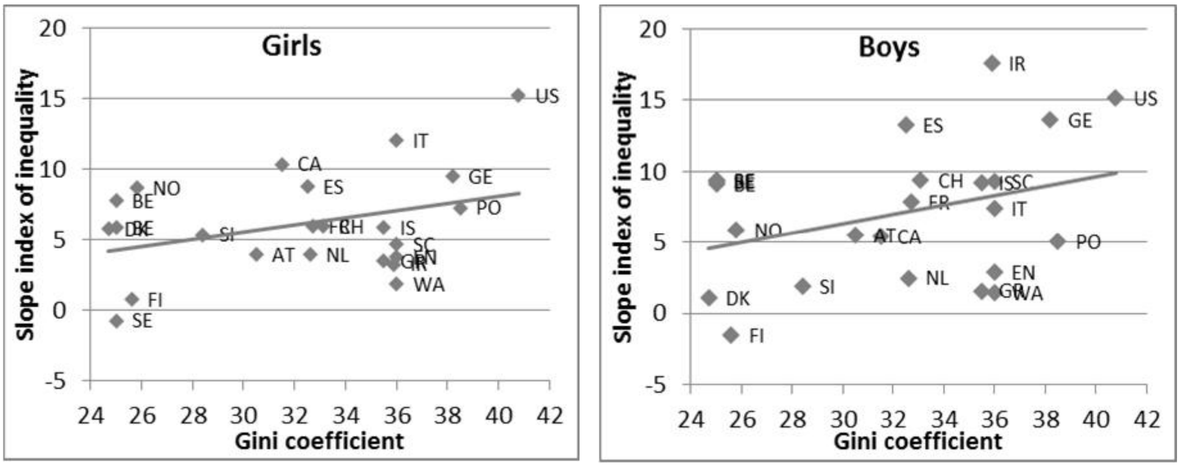
Lastly, Due and colleagues studied the role of income inequality in socioeconomic inequalities in overweight and obesity in 33 countries in Europe and America (Due et al., 2009a). The study used data from the Health Behaviour in School age Children study, a large international study that used standardised methods. Height and weight data were self-reported by adolescents and family affluence was reported by adolescents using the family affluence scale; the Gini coefficient was used to measure income inequality. The authors calculated absolute socioeconomic inequality in obesity using the Slope Index of Inequality.

The authors found that the relationship between income inequality and adolescent overweight varied by country-level income. Figure 4-14 shows the relationship between the level of income inequality (Gini coefficient on the x axis) and the level of absolute socioeconomic inequality in obesity among adolescents (slope index of inequality on the y axis) in high income countries. In high income countries, greater inequality was associated with higher overall prevalence of overweight (crude R^2=23.6-28.8) and greater absolute inequalities in overweight (crude R^2=11.5-12.2). In middle income countries the opposite relationship was observed - although these data from middle income countries have not been included in this review.

This difference in relationship between high and middle income countries could be explained partly by differences in the country-level income and the timing of the obesity crisis. Obesity tends to have a ‘positive’ gradient in low income countries (i.e. people from advantaged backgrounds are more likely to be obese). As countries become wealthier and the obesity pandemic progresses, the gradient shifts to a negative slope (i.e. people from more disadvantaged backgrounds are more likely to be obese) (Caballero, 2007). This could affect the relationship of the gradient and income inequality, and we would expect to see a clearer pattern of the relationship between income inequality and the social gradient in obesity in higher income countries, as shown in this study.

This study confirms that the social gradient in overweight is steeper in less equal countries among high income countries, although the opposite is true in middle income countries. As it is not possible to assess the height of the gradient, we cannot assess which models the study supports.

Figure 4-14: The relationship between income inequality (Gini coefficient) and absolute socioeconomic inequality in overweight (Slope Index of Inequality) for girls and boys in 23 high income countries, 2001-2



Source: graphs drawn using data from (Due et al., 2009a)

In summary, findings from studies comparing subjectively reported morbidity outcomes supported a range of models. In Banks and colleagues' analysis of the US and the UK, most of the outcomes supported model 2b (Banks et al., 2006a, Banks et al., 2006b). However, there was also some support for model 2a and 3a. Further support for 3a was provided by Lahelma and colleagues (Lahelma et al., 1994); Adler and colleagues' comparison supported model 3b (Adler et al., 2008). It was not possible to assign a model to Due and colleagues' (Due et al., 2009a) analysis.

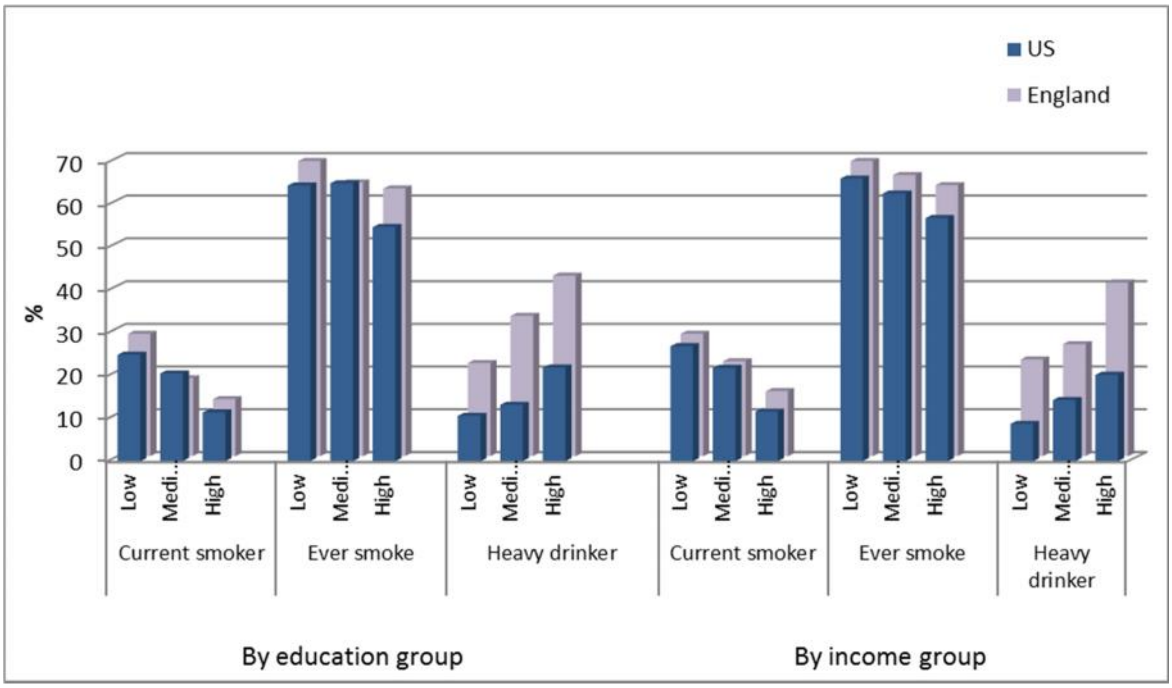
Socio-emotional wellbeing, mental health and behaviour

Studies on socio-emotional wellbeing, mental health and behaviour compared a wide range of outcomes. In total there were 4 studies, of which one analysed life satisfaction in adolescents, one compared depression in adults, one compared behaviour in children and one compared health behaviours in adults. The studies also used a wide range of measures of socioeconomic position. Only one study (Levin et al., 2010) analysed the role of income inequality.

Levin and colleagues analysed the interaction between income inequality at country level and socioeconomic position at individual level (Levin et al., 2010). The study assessed the role of national income, income inequality and family affluence in life satisfaction among 13 year old boys and girls, using comparable data from the Health Behaviour in School age Children survey in 35 countries. Life satisfaction was measured using Cantril's Ladder and SEP was measured using the Family Affluence Score. The authors employed multilevel linear regression. They found a curvilinear relationship between FAS and life satisfaction. There was no significant relationship between the Gini coefficient and life satisfaction (i.e. there was no relationship between income inequality and the level of the gradient). The cross-level interaction between the Gini coefficient and family affluence was found to be significant and positive, such that countries with more unequal income distribution had a steeper social gradient in life satisfaction. However, they concluded that the Gini did not explain country variance in socioeconomic inequalities in life satisfaction. However, it is not clear whether the level of life satisfaction was higher or lower in more equal countries, so we cannot say which model this analysis supports.

Banks and colleagues compared behavioural risk factors for chronic disease by education and income, using the same survey data from the US and England described above (Figure 4-15). They found that the prevalence of smoking was higher in England, which was more equal than the US, with little clear difference in the social gradient. This supports model 3a. For heavy drinking there was a positive gradient, such that people with higher socioeconomic status were more likely to drink heavily. Heavy drinking was also more prevalent in England, with little difference in the social gradient (model 3a).

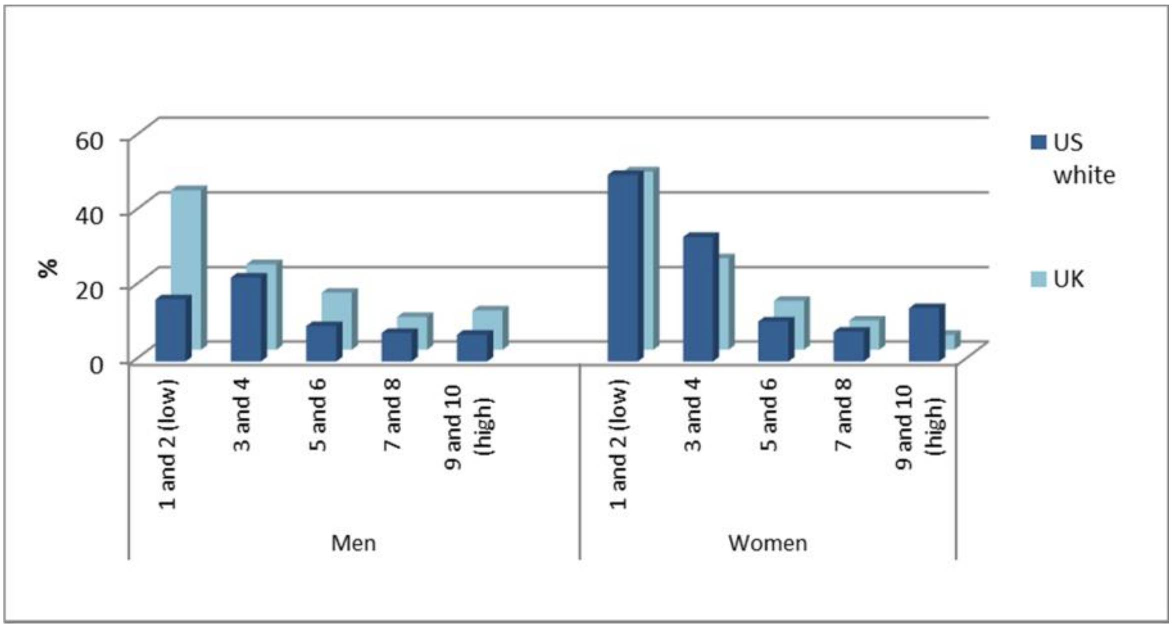
Figure 4-15: Prevalence of smoking and drinking by education and income group in England and the United States, ages 55-64, 2002



Source: graph drawn using data from (Banks et al., 2006b)

Adler and colleagues compared the prevalence of depression by Subjective Social Status, using the cohort data described above (Figure 4-16) (Adler et al., 2008). The prevalence of depression was generally lower in the US (the more equal country). There was little difference in the social gradient for women, but it seems shallower for men in the US for men. This supports model 3b.

Figure 4-16: Age-adjusted prevalence of depression, by subjective social status, US and UK



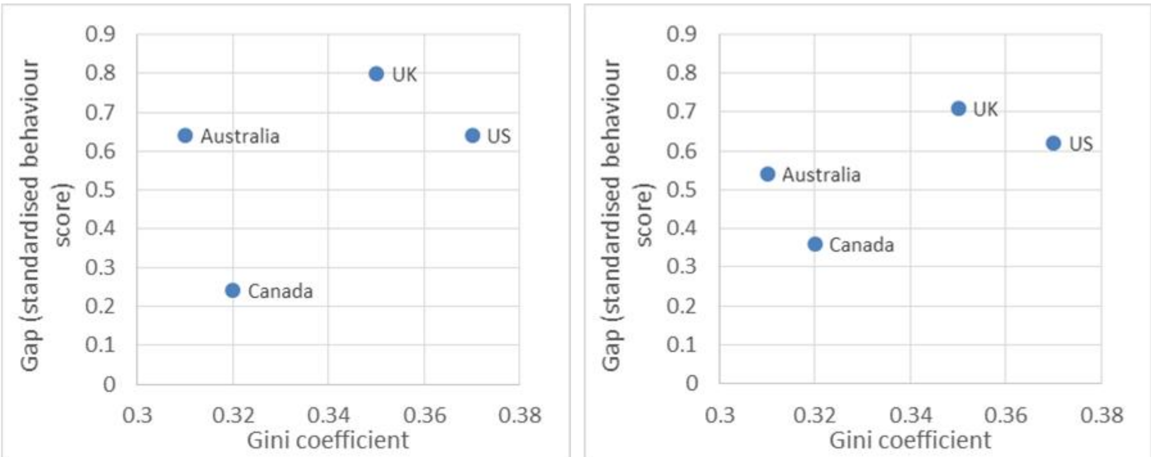
Source: graph drawn using data from (Adler et al., 2008)

Bradbury and colleagues compared cognitive and socio-emotional development outcomes in 4-5 year olds in Australia, Canada, the United Kingdom and the United States, from around 2004-2008 (Bradbury et al., 2010). The authors compiled data from four different cohort studies. There are therefore differences in the tests and scales which were used, although scores were standardised. Parental education and income were assessed and the gaps between the top, middle and bottom groups were presented. The authors presented the Gini coefficients (US 0.37, UK 0.35, Canada 0.32, Australia 0.31).

Figure 4-17 shows the size of the unadjusted gaps by parental education and income. These graphs do not easily allow comparison of the level of the social gradient, however they do enable comparison of the gaps. The gaps tend to be greatest in the UK (the second most unequal country) and smallest in Canada (the second most equal country). The most and least equal country (US and Australia) have similar sized inequalities. It is not possible to determine which model these data support.

Figure 4-17: Inequalities in child externalising behaviour in Australia, Canada, the UK and the US by parental education and parental income (gap between top and bottom group)

a) gap between top and bottom parental education group b) gap between top and bottom household income group



Source: (Bradbury et al., 2010)

In summary, only two of the four studies on socioeconomic, mental health and behavioural outcomes studied have sufficient information to assign a model. These support model 3a (Banks et al., 2006a, Banks et al., 2006b) and 3b (Adler et al., 2008).

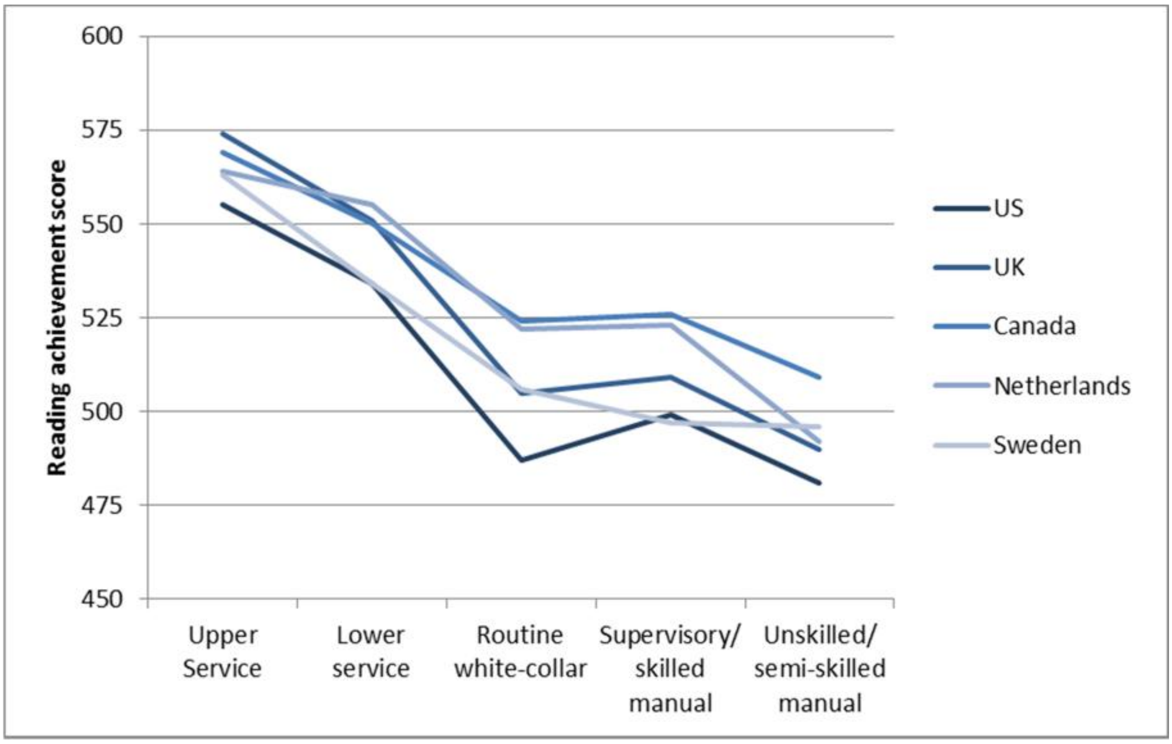
Cognition and education

There were four studies which reported cognition, literacy and behavioural outcomes for children, adolescents and adults. Of these, all assessed either reading or document literacy or vocabulary in either adults of children. One compared quantitative literacy, but did not provide a graph of the findings. Three of these studies used large international datasets; one analysed the role of income inequality (OECD, 2010).

Marks compared inequalities in reading scores from PISA (2000 data) at age 15 by parental occupation among 32 (mostly OECD) countries (Marks, 2005). It is worth noting that the proportions in different occupational groups and the social meanings of different occupations may be very different between these countries (for example, there are inconsistent findings for the level of literacy in the 'farm' category relative to other occupations between countries. The authors present the social gradient in mean reading scores (internationally standardised).

It is difficult to compare the social gradients among this large number of countries. I have therefore presented a graph of the 6 countries I used in my comparative cohort analysis in Figure 4-18, excluding the 'farm' category. The reading scores are lowest in the US, the most unequal country, across the social hierarchy. However, among the other countries there is no clear relationship with inequality, and the social gradients are similar (model 1).

Figure 4-18: Mean scores in reading achievement age 15 by parental social class, 2000, selected countries, excluding 'farm' category



Source: Graph drawn using data from (Marks, 2005)

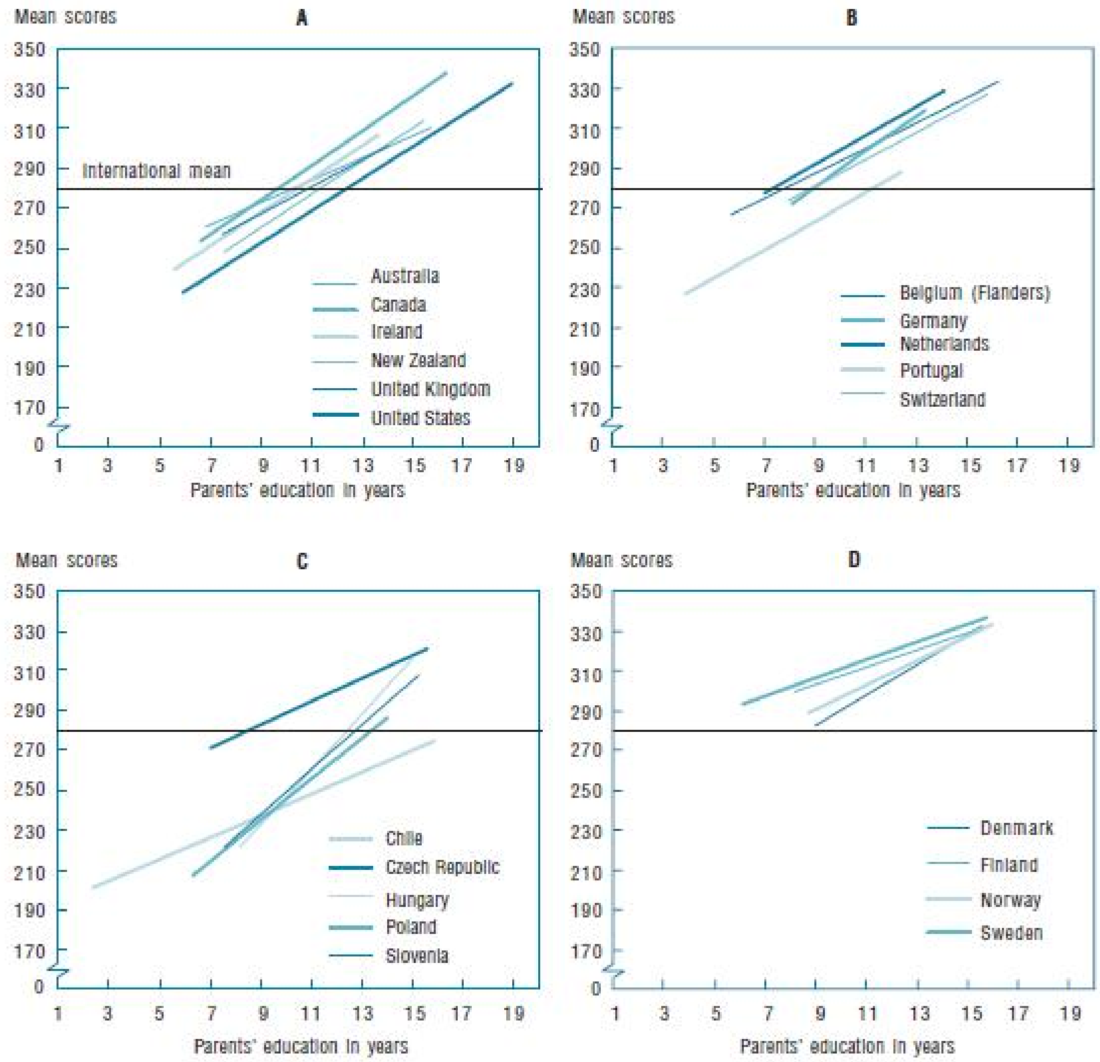
The OECD and Statistics Canada have analysed the social gradients in adult literacy in 16 countries (mainly OECD), using data from the International Adult Literacy Survey, 1994-1998 (OECD and

Statistics Canada, 2000) [1]. They analysed prose, document and quantitative literacy by parents' education. The methods are not clearly described, but the presented graphs of the social gradient (and a table of coefficients and intercepts from the models) (Figures 4-19 and 4-20). The countries are grouped by geographic, linguistic and economic criteria and compared qualitatively. These groupings reflect the Gini coefficients presented by the authors, with the most unequal countries in group A, and most equal in group D.

We can see from the graphs that literacy scores tend to be higher in the more equal countries in group D, where nearly all socioeconomic groups have scores above the international mean. The social gradient is also considerably shallower in these countries than the most unequal countries in group A. This supports model 2b – literacy is higher for all socioeconomic groups, with greater benefit for the poor in the more equal countries.

[1] A report from the Programme for the International Assessment of Adult Competencies (PIAAC) was released in October 2013 (OECD 2013. OECD Skills Outlook 2013. First results from the survey of adult skills. OECD publishing.). This reports similar analysis of social gradients in adult literacy using data from the most recent adult literacy survey. The findings are similar to those reported by the OECD and Statistics Canada report in 2000.

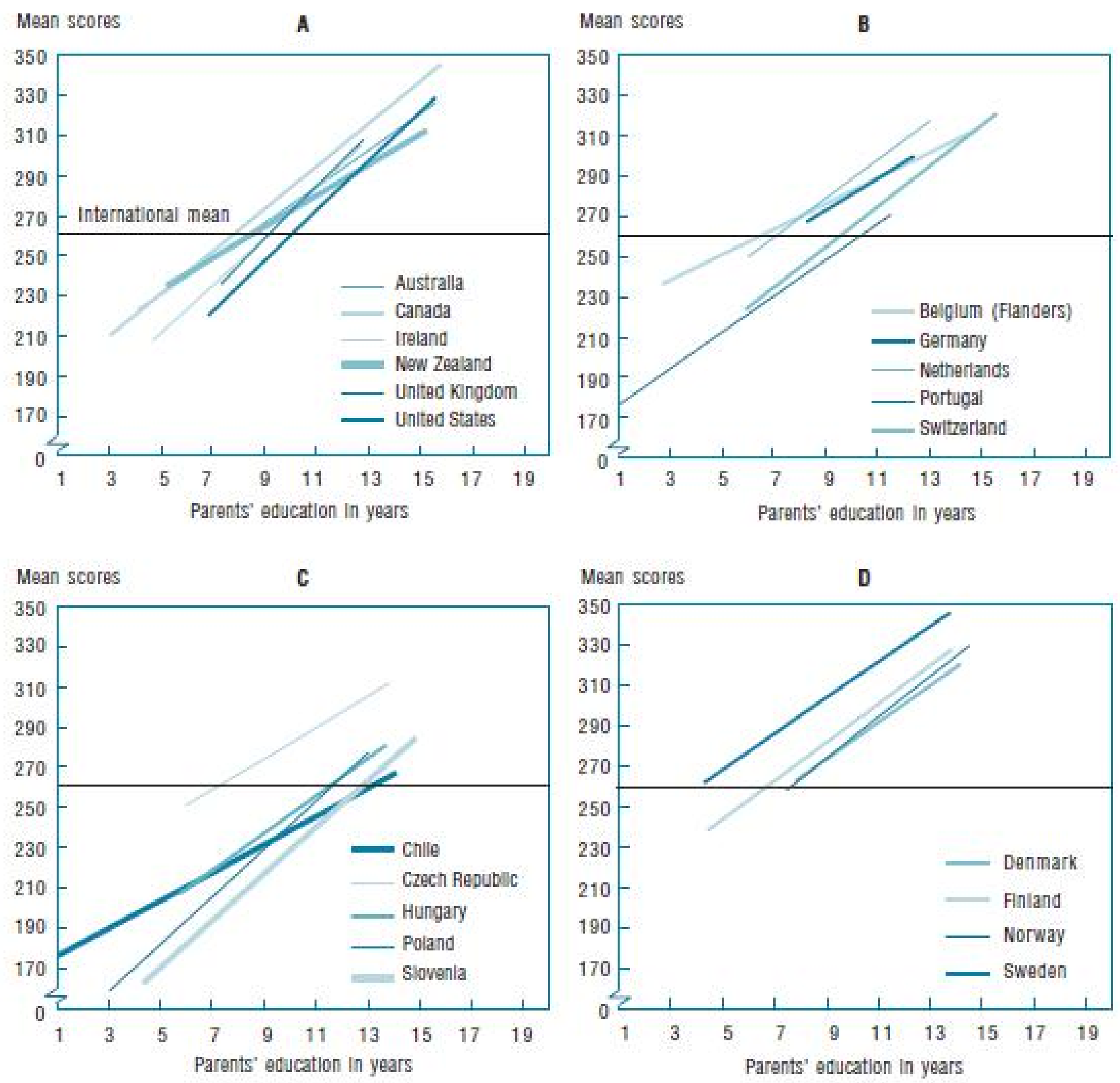
Figure 4-19: The relationship between document literacy scores age 16-25 and parents' education, 1992-1998



Note: graphs from the original report have been used; shade of blue does not represent the level of income inequality in this graph.

Source: (OECD and Statistics Canada, 2000)

Figure 4-20: The relationship between document literacy scores age 26-65 and parents' education, 1992-1998



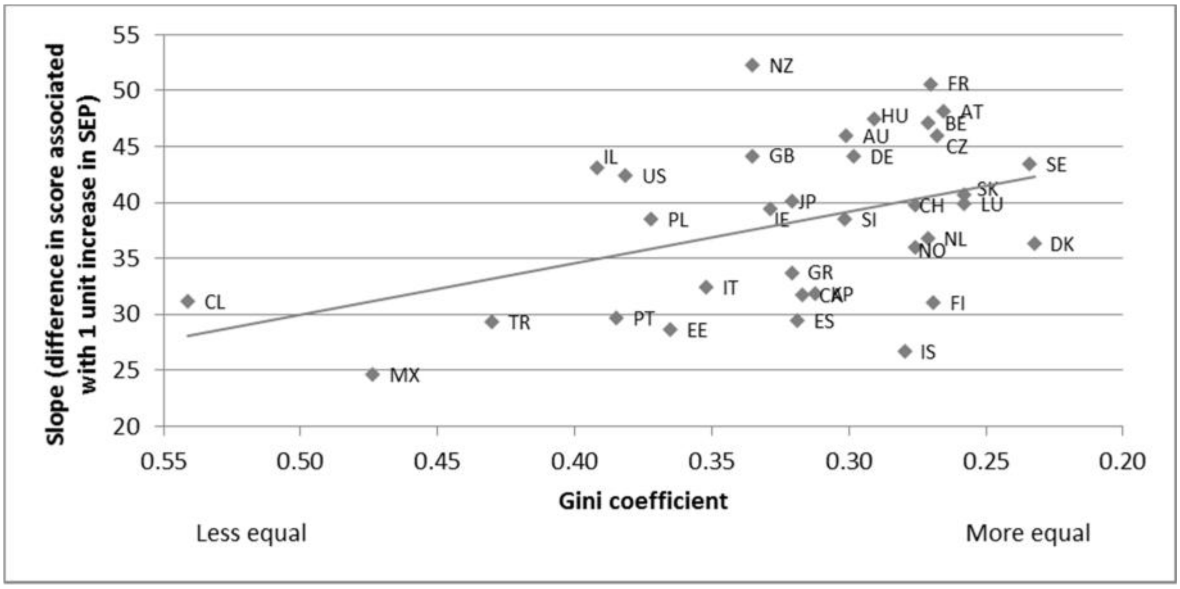
Note: graphs from the original report have been used; shade of blue does not represent the level of income inequality in this graph.

Source: (OECD and Statistics Canada, 2000)

The OECD have also published analyses of the results of PISA literacy surveys. The most recent has analysis of the different components of social gradients in each country and the role of income inequality using the large international PISA 2009 reading survey (more recent data than that analysed by Marks and colleagues) (OECD, 2010). Sixty-five countries were included in the analysis and PISA reading scores were standardised across countries (100 points=1 standard deviation). A socioeconomic background score was calculated combining parents' education, occupation and home possessions (standardised to mean=0, sd=1 for OECD countries). The authors calculated the components of the social gradient in each country, including the slope and height (level), but also the strength, length and linearity of the gradient.

This report showed that there was between-country variation in both the mean reading performance (level) and slope of the gradient line. The authors found that there was little relationship between level and the slope of the social gradient in reading for all countries (i.e. countries with high reading achievement were not more likely to have steeper or shallower gradients). Although the study reported the Gini coefficient for each country, the social gradient was not analysed in relation to income inequality. I have drawn a scatterplot to assess the relationship between income inequality (x axis) and the slope of the gradient (difference in literacy score associated with a 1 unit increase in SEP, y axis) in the OECD countries in the study (Figure 4-21). This graph suggests that the slope is steeper in more equal countries. However, there is not enough information to assign a model.

Figure 4-21: The relationship between income inequality and the slope of the social gradient in reading, OECD countries, 2009

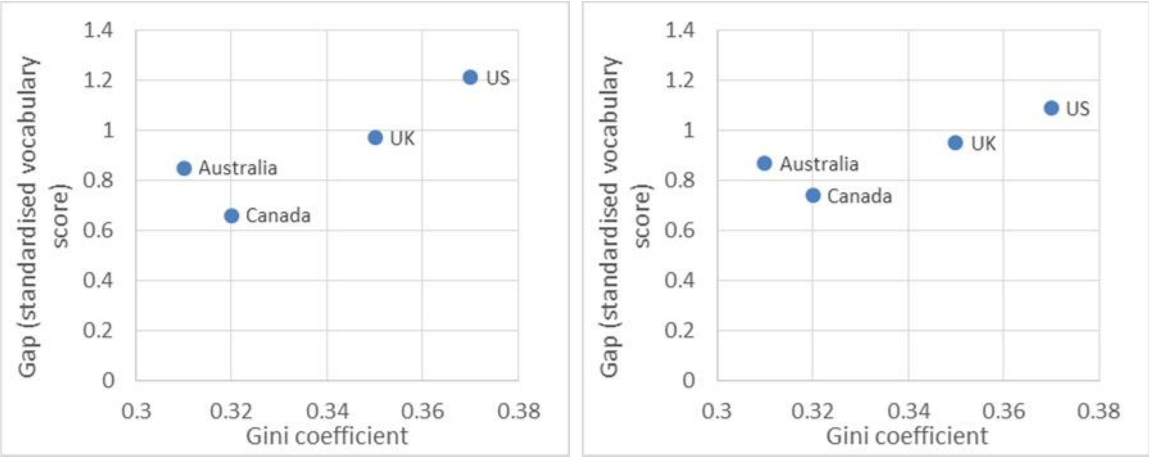


Source: graph drawn using data from (OECD, 2010)

Bradbury and colleagues compared vocabulary literacy gaps in the US, UK, Canada and Australia, using the methods described above (Bradbury et al., 2010). Figure 4-22 shows the size of the gaps. The figures used in the graphs were not reported in the paper, so it was not possible to redraw them in order to assess them in relation to the models. But they do show that the gaps are largest in the two most unequal countries (US and UK).

Figure 4-22: Inequalities in vocabulary outcomes in Australia, Canada, the UK and the US by parental education and parental income (gap between top and bottom group)

a) gap between top and bottom parental education group b) gap between top and bottom household income group



Source: (Bradbury et al., 2010)

In summary, only two of the studies on cognition and education have enough information to assign them to a model. One supported model 1 (Marks, 2005), the other supported model 2b (OECD and Statistics Canada, 2000).

4.4. Discussion

Summary and critique of the evidence

The review identified 13 studies that compared the social gradient in health or wellbeing between societies. Although few analysed the role of income inequality, it was possible to integrate study findings with income inequality data from other sources in order to answer the research questions.

Three research questions were posed:

- How does the *slope* of the social gradient vary in relation to income inequality? (Is the gradient steeper in more unequal countries?)
- How does the *level* of the social gradient vary in relation to income inequality? (Is health worse overall in more unequal countries?)
- *Does everyone do better in more equal countries*? (comparing both the slope and level of the gradient)

Nine models of the relationship between income inequality and social gradients were put forward to answer these questions. There was considerable variation in findings on the relationship between income inequality and social gradients in health and wellbeing. Overall, the greatest support was provided for model 2b: that *health and wellbeing are better in more equal countries; the gradient is steeper in more unequal societies; people with low SEP benefit the most in more equal countries*. None of the studies reviewed provided any support for models 2c, 3c or 4a. There was some support for models 1, 2a, 3a, 3b and 4b. A number of factors could explain the variation in findings.

First there are differences in the models supported by type of outcome. Table 4-2 summarises the models, by study and outcome measure. Studies which compared mortality or objectively measured morbidity largely showed better health and wellbeing in more equal countries, with most supporting greater benefits among people with low SEP (2b) and some showing equal benefits (2a). There was some evidence for no differences between more and less equal countries, especially for outcomes which do not have a social gradient (1). There was also some evidence for detriment and crossover (3a and 4b). Mortality rates and objectively measured morbidity are likely to be the most valid and reliable outcome measures.

For subjectively reported outcomes the findings were more varied. For physical health outcomes, there was some support for health benefits in more equal countries (2a and 2b), however there were also several comparisons which suggested a detriment to health in more equal countries (3a and 3b). In the category of socio-emotional wellbeing, mental health and behaviour, the two studies which had sufficient information showed that risk behaviours and depression were more prevalent in the more equal countries (3a and 3b). For all these self-reported outcomes we need to consider differences between countries in the wording of self-report questions and the effects of cultural and other contextual differences in reporting between countries. For example, a person’s response to the question: ‘Did a doctor ever tell you that you had hypertension?’ would be affected by factors including diagnostic thresholds in the country, the language that physicians use, and others (Banks et al., 2006b).

In the cognition category, the two studies found that literacy was better in more equal countries (2b), or that there was no difference (1). These studies used international surveys which measured literacy, although there may be cultural or other differences which affect people’s responses.

Table 4-2: Summary of the models supported by the different outcome measures in reviewed studies

Reference	Model supported								
	1. No difference	2. Benefit from equality			3. Detriment from equality			4.Crossover	
		2a. Equal benefit	2b. Greater benefit among low SEP	2c. Greater benefit among high SEP	3a. Equal detriment	3b. Greater detriment among low SEP	3c. Greater detriment among high SEP	4a. Equality benefit among high SEP; detriment among low SEP	4b. Equality benefit among low SEP; detriment among high SEP
Physical health and development Mortality									
(Leon et al., 1992)			• Neonatal mortality • Post neonatal mortality						
(Vagerö and Lundberg, 1989)			• All-cause mortality						
(Wilkinson and Pickett, 2008)	• All-cause mortality (65+) • Infant mortality • Diabetes • Prostate cancer • Breast cancer	• Ischemic heart disease	• All-cause mortality (25-64) • Respiratory disease • Homicide						• Alcoholic liver disease
Morbidity – objectively measured									
(Banks et al., 2006a) (Banks et al., 2006b)		• Hypertension	• Diabetes • C-reactive protein • Fibrinogen • HDL cholesterol						
(Adler et al., 2008)						• Hypertension			• Hypertension

						(women)			(men)
Morbidity – subjectively reported									
(Banks et al., 2006a) (Banks et al., 2006b)		• Cancer	• Diabetes, • Hypertension • All heart disease and myocardial infarction • Stroke • Lung disease • Obesity		• Overweight				
(Adler et al., 2008)						• Global health			
(Lahelma et al., 1994)					• Limiting long-standing illness				
(Due et al., 2009a)									
Socio-emotional wellbeing, mental health and behaviour									
(Levin et al., 2010)									
(Banks et al., 2006a) (Banks et al., 2006b)					• Current smoking • Ever smoking • Heavy drinking				
(Adler et al., 2008)						• Depression			
(Bradbury et al., 2010)									
Cognition and literacy									
(Marks, 2005)	• Reading literacy								
(OECD and Statistics Canada, 2000)			• Document literacy						
(OECD, 2010)									
(Bradbury et al., 2010)									

Second, there were differences by the way that SEP was measured. The measures used to measure SEP were: occupation (absolute categories), education (absolute categories), income (continuous and relative categories), family affluence (continuous) and subjective social status (absolute categories; measured relative to others in society). This has a number of implications. All three outcomes measured in relation to Subjective Social Status in the study by Adler and colleagues (2008) supported model 3c (detriment from in more equal countries, especially among people with high socioeconomic position). SSS may reflect different values in the two countries: the authors noted that SSS was more strongly linked to occupation in the Whitehall II study (UK), and to income in the US. They also suggested that SSS would have a stronger association with health in the UK due to the important role of social class in social identity. These differences would have affected the slope of the gradients observed in the two countries. Differences in other methods of measuring SEP between other studies also complicate comparisons.

As discussed in chapter 3, it is important to note the implications of using relative or absolute SEP groupings for comparisons of the slope of social gradients. If SEP is grouped using relative categories, e.g. quintiles, the slope may reflect both the size of differences in health and the size of differences in SEP. If we are comparing two countries using income quintiles, for example, a steep slope in one country may reflect large differences in health between the top and bottom quintile, but may also reflect a large range of incomes in the country, and large difference in income earned between the top and bottom quintile. Only one of the included studies used relative groupings of income(Banks et al., 2006b), however the findings by relative income group were supported by analysis by absolute education grouping.

Third, there are a number of cross-cutting issues related to the study methods employed which may have affected comparisons. Although some of the studies have discussed these issues, and their implications for cross-country comparisons, others have given limited information.

The choice of societies/countries and contextual issues may affect comparisons of the social gradient. This may occur due to cultural or contextual differences affecting either the collection or interpretation of SEP or outcome data in countries, as discussed above. The structure of society also affects the proportion of the population in each socioeconomic group, with implications for comparisons between societies. There is some evidence that the relationship between income inequality and the social gradient may differ between high and middle income countries (Due et al., 2009a). Due and colleagues found that the direction of the relationship varied between these groups (so when analysing both groups together there was little relationship). This highlights the importance of the selection of countries for the study. It would be interesting to see how stratification by high and middle income status would affect the relationships identified in other studies.

There may have been differences in the data collection and sampling strategy between countries being compared. This poses particular difficulties for comparisons of data from different surveys, but can also have implications for large international surveys. Some of the studies have used data from international surveys which used standardised data collection methods, although there may still be differences, for example due to translation. Others combined data from different sources with considerable differences in the survey design and data collection. Differences that could affect the comparisons include differences in the sample, for example whether it is nationally representative, whether it is community based or sampled from a work environment (e.g. Adler and colleagues compared a work-based sample with a community based sample). The indicators of socioeconomic position and health/wellbeing/development may be measured in different ways, for example using different question wording or a different number of response categories (this is a particular problem for self-reported data, e.g. subjective outcomes and SEP, as noted above).

It was often difficult to assess the quality of data, including the response rate, although this could have a considerable effect on social gradients. For example, the exclusion of a high proportion of children who are not enrolled in school in some of the countries for the school-based HBSC study may have affected gradients presented. The amount of missing data in society may affect the gradients reported. For example, Due and colleagues' (Due et al., 2009a), analysis of prevalence of overweight showed a lack of socioeconomic gradient in England. The authors suggested that this may be due to the large number of students with missing information on BMI in England (41%).

I did not include confidence intervals in the graphs, because they were not presented in many studies and they complicated the visual comparisons. However, this means that the strength of the gradient and error due to sample size (in particular, small numbers in some socioeconomic groups) could not always be judged. It was not always clear whether there were significant differences between countries.

There was considerable heterogeneity of methods of analysis, which made comparison of different studies difficult. Health inequalities were measured using absolute differences between groups, and regression coefficients. Although this did not affect comparisons of the slope or level within studies (between societies), it reduces opportunity for comparison across studies. Therefore I could only make qualitative comparisons and was not able to test or pool findings. Where data from different sources have been used, there may be differences in where cut-offs have been set for the variables. The way that missing data has been dealt with is often not reported, and there may be differences between countries. There were also differences in variables that were controlled for, ranging from no controls to a range of variables in multilevel analysis.

Finally, we should note that many of the studies reviewed compared small numbers of countries (many compared only 2, 3 or 4). It is very difficult to draw conclusions about country-level effects from such small sample sizes. However, such studies can contribute to the evidence base and, taken as a whole with other studies in the review, help us to build up a picture of the way the social gradient varies between more and less equal countries. The review highlights the need for studies comparing the social gradient across a larger number of countries with different levels of income inequality.

Limitations

There are a number of limitations to this review. The main limitation was the difficulty searching for literature. There may be other studies that address the research questions that I was not able to identify. There were also considerable methodological differences between the studies, as discussed in detail above. Differences in variables used and different ways of measuring variables make comparisons between studies difficult. Some studies had analysed the slope and level, but did not provide graphs or absolute figures. This made it difficult to assign models of the gradient.

Areas for future research

The review has identified a lack of knowledge on differences in the social gradient in relation to income inequality. I have identified only four studies that have explicitly analysed the role of income inequality in social gradients in health or wellbeing, (and report information that allow us to compare social gradients) (Wilkinson and Pickett, 2008, Due et al., 2009a, Levin et al., 2010, OECD, 2010). Furthermore, the review has identified a lack of studies that have conducted robust comparisons of the social gradient in health or wellbeing between countries, with harmonised samples and variables. Although numerous studies have compared relative inequalities in health across societies, few have presented absolute measures of inequality required to compare the slope and level of the social gradient.

4.5. Summary of chapter 4

This chapter reviewed studies that have compared the social gradient in health and wellbeing between high income societies with different levels of income inequality.

1) I included 13 studies that have assessed the social gradient in health/development/wellbeing in different countries. Where studies did not consider the role of income inequality, I introduced data on income inequality and re-drew graphs.
2) I identified 9 different models of the relationship between income inequality and social gradient in health. These were then assessed in relation to evidence from the studies.
3) There was considerable variation in findings on the relationship between income inequality and social gradients in health.
    - The most widely supported model of this relationship was 2b: health and wellbeing are better for people in all socioeconomic circumstances in more equal societies, the gradient is steeper in more unequal societies and people with low SEP benefit the most in more equal societies. This model was most supported by comparisons of mortality and objectively measured morbidity.
    - Evidence from comparisons of self-reported morbidity, self-reported socio-emotional, mental health and behavioural outcomes and cognition was more varied and conflicting, with some showing benefits in the more equal country and others showing detriments.
4) There were a wide range of issues concerning methods used for data collection and analysis and data quality which may have affected comparisons of the social gradient.
5) Only 4 studies have specifically analysed the relationship between income inequality and the social gradient in health or wellbeing. This supports the need for further studies in this area.

PART II: COMPARATIVE COHORT ANALYSIS

Chapter 5: Comparative cohort analysis - Background and methods

This chapter provides a background to the comparative cohort analysis and an overview of the methods used. It starts with some background information on harmonising cohort studies, including considerations to take into account to improve comparability. I then present some background information on the studies included in the comparative cohort analysis. Finally, I describe the methods used, including the sample selection, which variables were used and how they were harmonised, and the stages of analysis.

5.1. Introduction

There is a lack of evidence on how the social gradient in health and development differs between more and less equal countries. I therefore conducted a comparative cohort analysis to compare social gradients in child health/development in relation to income inequality. I chose cohort studies from countries with low, middle and high levels of inequality to compare. I analysed gradients in health and development for children aged 4-6 in relation to parental education and household income.

This chapter provides an introduction to the comparative cohort analysis and gives an overview of methods used.

Objective and research questions

The comparative cohort analysis addresses thesis objective 3*: To analyse and compare social gradients in child health and development using data from high income countries with different levels of income inequality*

There are a number of specific objectives for the comparative cohort analysis

i. To harmonise cohort studies in terms of sample and variables
ii. To analyse and compare social gradients in child health and development in each cohort
iii. To critically appraise the validity of comparisons

Analysis and comparison of social gradients will focus on the three overarching research questions:

- How does the *slope* of the social gradient vary in relation to income inequality? (Is the gradient steeper in more unequal countries?)
- How does the *level* of the social gradient vary in relation to income inequality? (Is health worse overall in more unequal countries?)
- *Does everyone do better in more equal countries*? (comparing both the slope and level of the gradient)

5.2. Background on the analysis of multiple cohort datasets

In order to inform the methodology for my analysis, I reviewed literature on different approaches to the analysis and comparison of multiple datasets. I also reviewed the challenges with analysing multiple datasets and possible ways forward.

Background and terminology

A range of approaches have been used in different disciplines to combine and analyse data from independent datasets, including cohort studies. These can be summarised into two broad approaches:

a) Approaches that conduct separate**, coordinated analyses** in each dataset, then conduct comparisons or develop a pooled estimate;
b) Approaches that pool datasets then conduct one **pooled analysis** using the single, combined dataset

The key features of coordinated and pooled analysis are summarised in Table 5-1.

Table 5-1: Coordinated/meta-analysis and pooled analysis features

Coordinated analysis/meta-analysis	Pooled analysis
• Two step analysis: multiple analyses of separate datasets, followed by comparison or meta-analysis	• One step analysis: single analysis in pooled dataset
• Can include cohort-specific covariates - use best model for each cohort, but - lose comparability	• Use the same covariates for all cohorts - maintain comparability, but - lose some information in the model
• Cannot use a multilevel model. Can use fixed or random effects meta-analysis or descriptive comparative analysis	• Can use multilevel modelling to analyse individual level and study level effects
• Can be decentred; datasets can be analysed in different locations	• Requires all datasets to be in one location to be pooled and analysed

Within these two broad approaches, a range of different terms have been used. In Box 5-1 I have defined these terms, starting from the least collaborative and comparable, decentralised approaches, through to the approaches that pool datasets. These approaches can combine any type of dataset, including cohorts. This is frequently termed 'harmonisation' of datasets. Harmonising longitudinal studies, such as birth cohorts, poses some particular challenges, which are discussed below.

In this thesis I am using the term 'coordinated analysis'. This term most closely overlaps with my aim and proposed methods: I am conducting individual analysis of datasets, in different geographical locations (due to logistical barriers to pooling datasets), in a manner that optimises comparability.

Box 5-1: Terminology used by studies that have combined multiple datasets

Combining datasets: terminology

Meta-analysis
The separate analysis of individual datasets, followed by meta-analysis of the results. This approach has been used in many disciplines, especially epidemiology. The separate analyses may be conducted in a collaborative, comparable way, but are usually conducted independently. The resultant differences between data and analysis pose challenges to meta-analysis of findings.

Coordinated analysis
A more collaborative approach, in order to ensure that the individual analyses are conducted in a more comparable way. This has been defined as: "collaborative analysis of multiple independent data sets in ways that optimize comparison of results across studies" (Hofer and Piccinin, 2009, page 152).

Mega-analysis
This term have been used to describe the pooling of raw data (in contrast to pooling estimates in meta-analysis). These aim mostly to pool samples to produce one overarching analysis, in order to test relationships across samples, cultures etc., although studies using mega-analysis have evaluated both individual-level and study-level effects.

Pooled analysis/data pooling
Combining datasets to conduct a single analysis. This term seems to have been used in epidemiology in particular, e.g. in cancer epidemiology to identify risk factors for cancers. Although it could involve different approaches to analysis, it is often used to describe data analysis that aims to pool samples in order to achieve a larger sample size and a more accurate effect size, or to study a rare outcome (rather than to compare differences between studies). This is similar to mega-analysis.

Integrative data analysis
This has been defined as "the statistical analysis of a single data set that consists of two or more separate samples that have been pooled into one" (Curran and Hussong, 2009, page 82). This term seems to have been used in psychological disciplines and ageing research, e.g. (Hofer and Piccinin, 2009).

The growth of coordinated analysis

There has been a growth in the use of coordinated and pooled data analysis across various disciplines, including medicine and epidemiology, psychology and ageing research, over the last ten years. In particular, integrative data analysis has been an emerging field in psychology, with a cluster of papers about methods published in the last 5 years, e.g. (Curran and Hussong, 2009, Curran et al., 2008, Hofer and Piccinin, 2009). This growth may be related to increased opportunities for pooled analysis due to greater data sharing and better electronic storage and retrieval of data (Curran and Hussong, 2009). However, I have found few articles that have used coordinated or pooled data analysis in social sciences or social epidemiology – this may reflect the greater challenges of harmonising datasets and variables to study the social meaning of factors (rather than clearer, more easily comparable exposures e.g. diet in cancer epidemiology).

Why conduct coordinated or pooled analysis?

Harmonising datasets offers a variety of advantages for different types of coordinated or pooled analysis studies. For this thesis, the main advantage is that harmonising data from different contextual settings allows you to compare patterns and relationships in different contexts. There are a number of other potential advantages (although not relevant to this thesis). Some authors have harmonised samples of different age groups in order to increase the age span/developmental period for analysis. Pooled samples may also provide increased statistical power, increase the frequencies of rare behaviours or outcomes and allow tests for replication of findings across samples (Curran and Hussong, 2009, Curran et al., 2008).

Harmonising studies also forces us to consider issues, e.g. measurement, in each individual study in more depth than we otherwise might have done.

Harmonisation of multiple datasets

In analysis of multiple datasets it is difficult to tell if comparative findings are due to:

a) methodological differences between the studies
b) errors in the comparative method, or
c) actual population differences (Bath et al., 2010)

In order to understand findings and be as certain as possible that observed findings do reflect real population differences, it is essential to identify sources of heterogeneity between datasets and adopt approaches to minimise and take account of these differences. This includes the harmonisation of datasets and variables to minimise differences. Harmonisation could be defined as *the process of identifying and minimising differences between multiple datasets in order to conduct comparative analysis, including the development of comparable variables*.

Where harmonisation is not possible, we need to take differences into account in data analysis and interpretation of study findings.

It is important to consider differences between datasets at each step of the research process, including the following steps:

a) Identify differences between the datasets
b) Harmonise datasets to minimise differences through:
    - the development of comparable samples and exclusion criteria
    - the development of harmonised variables
c) Take account of differences during data analysis
d) Take account of residual differences during interpretation of findings

How do cohort datasets differ and how can we take account of differences?

There is inevitably heterogeneity between different studies. We may be directly interested in analysing these differences, or try to control for them to reduce heterogeneity (Curran and Hussong, 2009). In this thesis I am interested in contextual differences between the study countries, but will need to identify and, where possible, reduce other sources of heterogeneity between the cohort studies.

A number of papers on harmonisation of studies have identified potential sources of heterogeneity, e.g. (Hofer and Piccinin, 2009, Curran and Hussong, 2009, Bath et al., 2010). In the following section I have drawn from this literature to summarise the main sources of heterogeneity between cohorts.

After identifying the sources of heterogeneity between studies, we can harmonise datasets to minimise each type of heterogeneity. Where harmonisation is not possible, we need to take differences into account in data analysis and interpretation of study findings. However, it can be difficult to assess the effects of heterogeneity because there are likely to be multiple differences between studies and it is difficult to isolate the effects of particular differences (Curran and Hussong, 2009).

In the following section I have summarised the main sources of heterogeneity between cohort datasets and identified whether each of these issues is applicable to my research. I have added discussion of the different methods authors have used to minimise these types of heterogeneity and identified the most appropriate approaches for my thesis.

i. Sample and response

Studies differ in terms of their initial sampling frame and the population represented by the sample. In my study, although I have chosen cohorts that aimed to achieve a nationally representative sample as far as possible, there are some differences, for example Gen-R sampled from one city and ABIS sampled from one area of Sweden. There are also differences in terms of ethnicity, for example the MCS has oversampled people from ethnic minority groups; the LSAC has purposefully sampled from indigenous groups; the NLSCY has excluded some first nations groups.

The sampling frame can affect the meaning of harmonised variables and findings, if relative categories are created. For example, comparisons of quintiles of income between studies can be difficult to interpret if the sampling frame differs. The meaning of absolute categories (e.g. absolute parental education groups), on the other hand, is less affected by the sampling frame.

One option to deal with different sampling frames is to define inclusion and exclusion criteria in order to create similar samples during harmonisation. For example, Banks and colleagues excluded non-white and Hispanic people from their comparison of the social gradient in health in the US and UK (Banks et al., 2006b). The use of weighting variables to take account of over/under-sampling of groups in the sample and attrition can also be used in analysis.

The age of recruitment may also affect the sample achieved. For example, the CHICOS study has found that there are fewer seriously ill children than expected in the MCS. The MCS recruited later than many birth cohorts (at 9 months), so mothers of children who were seriously ill at 9 months may have chosen not to take part – a selection bias (personal communication at CHICOS workshop). Of the studies included in my analysis, this should be considered for the studies that recruited after birth: MCS (9 months), LSAC-K and ECLS-K (kindergarten). Althoug, this is unlikely to be an important issue for studies of outcomes that are not disabling for children (e.g. height), it may play a role in the prevalence of severe illness in the sample.

Finally, there are likely to be differences in response rates at the initial sweep and attrition (unit non-response) in later sweeps in longitudinal studies. The cohort weighting variables can be used to adjust for non-response in the first sweep and attrition in later sweeps. Item non-response may also pose problems for comparability. This needs to be described and could be dealt with in a comparable way, for example using similar imputation approaches. All the cohorts also have item non-response (summarised chapter 6). However, there are also differences in how missing data has been dealt with within cohorts (discussed below).

ii. Other design and analysis characteristics

The child's age at which sweeps take place differs between cohorts, with a number of implications for harmonisation, analysis and interpretation. Child age clearly affects health and development outcomes, e.g. height or cognition. The main ways to deal with this are to select sweeps when children are as similar in age as possible and to control for child age in the analysis.

Child age could affect interpretation of SEP variables. For example, the timing of the first sweep differed between cohorts. In some of the cohorts the data collection took place during the period of time that mothers could be on maternity leave (e.g. MCS at 9 months, QLSCD at 5 months). This may affect the household income, depending on maternity policies in the different countries.

Another important design characteristic that varies between cohorts is the choice of respondents, their relationship with the cohort child, and which questions they answer.

iii. Context and history

Contextual differences in the level of income inequality in the country are the differences that I am interested in analysing. However, it is also important to consider other contextual differences, such as differences in culture, policies (e.g. social welfare policies and programmes) or other macro-economic or social differences (Hofer and Piccinin, 2009). In a pooled dataset, the most important differences can be added as covariates at the country level, e.g. adding national GDP, year. In coordinated analysis, these differences need to be taken into account during interpretation of findings.

Cultural differences could also affect the measurement and interpretation of covariates. For example, there are country differences in education norms. Therefore although education may be a good marker of SEP in all countries, a university degree, for example, may have different implications for people's social status and income in different countries. This needs to be taken into account in the development of harmonised variables and interpretation of findings. These differences are discussed further in the measurement section below.

If data in the studies were collected in different years, there will also be historical differences. For example, the 'norms' of education have changed over time and child obesity rates have increased over time. I can minimise this by selecting cohorts that started as close to the year 2000 as possible and controlling for year of data collection.

iv. Variable definition and measurement

There are many differences in which variables are collected, how they are defined and how they are measured. In many cases it is possible to 'transform and recode' to develop harmonised variables in order to minimise these differences (Bath et al., 2010)

We can think about variables in terms of whether they have *measurement* equivalence (i.e. are measured in the same way) and whether they have *conceptual* equivalence (i.e. have the same meaning – related to contextual differences discussed below). These terms (and many other forms of equivalence) have been used in cross-national survey research (Johnson, 1998), but are also useful for harmonisation of cohorts. Variables measured in the same way do not necessarily have the same meaning between cohorts, e.g. a university degree may have different meanings in terms of status, as noted above. On the other hand, it may be possible for variables to be measured differently, but have conceptual equivalence, e.g. different categories of education may have similar social and economic implications between countries due to differences between education systems.

There are a number of different types of measurement differences. First, there are usually differences in what has been measured. For example, the QLSCD asked parents about the number of years of schooling they have achieved; the MCS did not.

Cohorts may measure similar variables, but with differences in question wording or instruments used. For example, child hyperactivity and attention has been measured in different ways (the LSAC and MCS have used the SDQ; the NLSCY has a locally developed scale). In this case it is important to determine whether studies seek to measure the same underlying theoretical construct. If not, the variables should not be harmonised. If they do, there are a range of approaches that have been used to harmonise variables (Curran and Hussong, 2009, Bauer and Hussong, 2009). Where authors have been certain that 2 different scales or scores are measuring the same underlying construct, they have computed a standardised score. This is usually calculated using mean=0, sd=1 using the survey weights, but can be standardised to mean=100, sd=10, as in (Huerta et al., 2011, Bradbury et al., 2010). Other techniques have also been used, e.g. Bath and colleagues harmonised two different cognitive impairment scores by dividing by the number of items on the scale (Bath et al., 2010). However, this method does not take into account the different mean and distribution of scores for the two scales. Item response theory is also increasingly used to compare across different scales which measure the same underlying construct (Curran and Hussong, 2009).

There may be differences in the technique for measurement. For example, most cohorts use largely face-to-face interviewing, but the Gen-R cohort uses many written surveys for parents to fill in. It is possible that this affects the way people answer questions. Preceding questions in the survey may also affect the responses that people give, so differences in question order could be considered. Language differences may also affect the nuanced meaning of questions.

In some cases, the cohorts have collected data on the same variables, but there are differences in the response categories or the way that responses are coded. For example, household income is available as a continuous variable in some cohorts, but banded in others. The units or scales of responses also vary. An obvious difference is currency for household income. Previous studies have harmonised differences using conversion to a common unit (e.g. PPP$) or standardisation (OECD, 2010).

In summary, measurement differences are likely to be numerous, but there are many options for harmonisation of variables in order to minimise these differences. Remaining heterogeneity needs to be taken into account in interpretation of findings.

v. Management characteristics

Finally, there are differences in how the data are managed between cohorts. There are differences in how missing data have been dealt with by the cohort managers. Some of the cohorts have left missing data for analysts to deal with; others have already imputed missing data, for example the Canadian NLSCY has imputed income data for a quarter of the cohort children (to impute missing data and to replace data considered invalid). There may also be differences in the amount of data cleaning between cohorts.

In summary, there are many differences between the cohorts, in terms of sampling and response, other design features, context and history, measurement and management of data. However, as Curran and Hussong note: "*it is not only unrealistic but also not useful to exhaustively identify, track, and code the entire set of differences in design characteristics across the set of contributing samples. A more useful goal is to identify those specific characteristics that are thought to be most salient for the given application at hand*" (Curran and Hussong, 2009, page 90). Coordinated analysis of cohort studies should therefore focus on identifying the most important differences between datasets, in order that they can be minimised through harmonisation and analysis and taken into account during interpretation of findings.

5.3. Comparative cohort study methods

This study employed a coordinated analysis approach to comparison of data from 7 cohort studies from 6 high income countries. I harmonised the samples and variables in order to analyse social gradients in health and development and compare findings between cohorts.

In order to compare the gradients across cohorts, I developed the following stages of analysis.

- Harmonisation of datasets. I first harmonised the datasets by developing exclusion criteria and harmonised variables. The methods I used for this are outlined in detail in this chapter.
- Analysis and comparison of findings
    - Descriptive statistics. I prepared descriptive statistics to compare both the unweighted samples and weighted population statistics between cohorts. These are presented in chapter 6.
    - Preliminary analysis and comparison of social gradients in child health and development. I presented unadjusted social gradients in child health and development separately in each cohort. I present and compare these findings in chapter 7.
    - Regression analysis and comparison of social gradients in child health and development. I finally conducted regression analyses in each dataset, in order to control for differences in age and sex. I present and compare these findings in chapter 7.

5.4. Sample

Study countries and cohorts

I selected 6 study countries to compare based on two criteria:

1) Level of income inequality – countries with different levels of income inequality were selected in order to analyse the relationship between income inequality and social gradients in child health
2) Availability of appropriate data – countries with accessible individual level data on children, including parental and household SEP variables and child health and development outcomes were selected. I chose countries and accessed data sources in collaboration with the INRICH network (the International Network for Research on Inequalities in Child Health).

In order to compare countries with different levels of income inequality, I have created three groups of countries with different levels of income inequality:

- Group A: High income inequality
- Group B: Medium income inequality
- Group C: Low income inequality

Countries were assigned to each group, using the Gini coefficient (at the time of data collection for the sweep of data used) in each country. The study countries, data sources and groups are summarised in Table 5-2.

The different measures of income inequality and comparability of inequality data sources were discussed in chapter 3. I selected the Gini coefficient to summarise income inequality levels primarily due to the presence of comparable data from the SWIID database (data on the 10:90 gap were not available for all countries in the SWIID).

Table 5-2: Study countries, groups and dataset

Group	**Country *(Region)***	**Cohort study**	**Year** (for data used in analysis)	**Gini Coefficient ***
Group A: High inequality (Gini≥34)	United States	Early Child Longitudinal Study (ECLS-K)	1999	37.0
	United Kingdom	Millennium Cohort Study (MCS)	2006	34.8
Group B: Medium inequality (Gini ≥30, <34)	Canada	National Longitudinal Survey of Children and Youth (NLSCY)	2003	31.7
	(Quebec)	Quebec Longitudinal Study of Child Development (QLSCD)	2003	**
	Australia	The Longitudinal Study of Australian Children (LSAC-K)	2004	31.1
Group C: Low inequality (Gini <30)	The Netherlands *(Rotterdam)*	Generation-R (Gen-R)	2010	26.8
	Sweden *(Southeast Sweden)*	All Babies in Southeast Sweden (ABIS)	2003	22.2

*Gini coefficients (net) from the SWIID database

** The data from Quebec have been assigned the Gini coefficient for the whole of Canada for this analysis. Comparable data on the Gini in Quebec are not available. Differences between Quebec and the rest of Canada are discussed in chapter 8.

Table 5-3: Features of included cohort studies

	ECLS-K (US)	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Quebec)	Gen-R (Netherlands)	ABIS (Sweden)
First year	1998/9	2001/2	2004	Original longitudinal survey started 1994-5 (age 0-11) New children recruited at each cycle	1997/8	2001-2005 (Mothers with a delivery date from April 2002 until January 2006)	1997-1999
Child age at recruitment	4-6 years	9 months	4-5 years	0 to 11 months, 1, 2 to 3, 4 to 5, 6 to 7, 8 to 9, and 10 to 11 years	5 months	During pregnancy	During pregnancy
Year when children were age 4-6	1998/9	2006	2004	Every cohort year contains 5 year-olds	2003	2008-2012	2002-4
Age at sweeps	Kindergarten First grade Third grade Fifth grade Eighth grade (ages vary within each grade)	3 years 5 years 7 years 11 years	4-5 years 6-7 years 8-9 years 10-11 years 12-13 years	0 to 11 months, 1 year 2 to 3 years 4 to 5 years 6 to 7 years 8 to 9 years 10 to 11 years	17 months (1 year) 29 months (2 years) 41 months (3 years) 53 months (4 years) 5 years	0 3 months 6 months 12 months 18 months 24 months 30 months 36 months 48 months 5-6 years	0 1 year 2.5-3 years 5-6 years 8-9 years 11-13 years
Sample size (baseline)	22,666 children in fall and/or spring (not all took part in fall and spring interview)	18,819 children	4,983 children	Total 22,831 children 0 to 11 years (2,227 age 0) But more recruited each year	2,223 children (2,120 were retained for the longitudinal study)	9,778 mothers (9,745 known live-born children)	17,055 children

(Figure 5-3 continued)

	ECLS-K (US)	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Quebec)	Gen-R (Netherlands)	ABIS (Sweden)
Sampling strategy (baseline)	National sample of kindergartners. Multistage sampling. Primary sampling units were counties. Public and private schools with Kindergartens were selected from PSUs; oversampled from private kindergartens. Children were sampled from Kindergartens. Top-up after 1 year from first grade.	National sample Sampled from child benefit register Oversampling of disadvantaged areas, ethnic minority groups, Scotland, Wales and NI.	National sample. Two-stage clustered design (postcodes, then children selected from the Medicare Australia list). Sampling was stratified by state/city statistical division to ensure proportional geographic representation.	National sample Several different sampling frames. Main sampling frame is Labour Force Survey for cycles 1 and 2.Some were sampled from National Population Health Survey. Sample drawn from Birth Registry for cycles 3 and 4 Some exclusions (see Appendix 5)	Target population is singleton births, 59 or 60 weeks of gestational age, born to mothers residing in Québec, with some exclusions. Stratified 3-stage sampling design (PSUs/regions, SSUs, TSUs). Sample was selected from birth registry. Some exclusions (see Appendix 5)	All pregnant women in defined postcode areas of Rotterdam (areas cover over half of the city's population)	All pregnant mothers in Southeast Sweden
Respondents	Mother, father, teacher, child assessments, School	Main respondent (majority natural mothers), partner respondent (usually in same household). teacher, child assessments	Parent 1 (usually mother), parent 2 (parent 1's partner), parent living elsewhere, teachers and childcare workers, child assessments. Linked to Medicare Australia; Census; National Assessment Program	Person most knowledgeable about child (PMK; usually mother) and spouse, teacher (dropped after 2004), Child assessments	Person most knowledgeable (nearly always mother), child assessments, biological parent, if applicable	Mother, father (partner of pregnant woman at recruitment), child assessment	Mother, father, child assessments

In most countries I analysed one dataset. I was able to access two datasets from Canada: the NLSCY is a national cohort and the QLSCD is a cohort from Quebec province. Although there are some differences in income inequality and other contextual factors between Quebec and the rest of Canada, I have analysed the QLSCD as part of Group B with the NLSCY. The implications of these differences in context are discussed in chapter 8.

Where possible, I used datasets with nationally-representative samples. However, these were not available in all countries. Datasets with nationally representative samples were included from the UK (MCS), US (ECLS-K), Australia (LSAC-K) and Canada (NLSCY); sub-national datasets were included from the Netherlands (Gen-R sampled from Rotterdam city), Sweden (ABIS sampled from Southeast Sweden) and Canada (QLSCD sampled from Quebec province).

All included datasets were cohort studies, although they were analysed cross-sectionally. I was also open to the inclusion of relevant cross-sectional datasets, however the included cohorts met the inclusion criteria and could be accessed.

Background information on study cohorts

A summary of the features of each cohort is provided in Table 5-3. Further information on each of the study cohorts is provided in Appendix 5.

Within-country harmonised samples

I defined samples within each dataset, with the aim of maximising comparability between datasets, by reducing differences as a result of heterogeneity in sampling and response. I also took into account the implications of sampling for analysis and interpretation of findings. I therefore defined a number of inclusion and exclusion criteria.

First, I analysed data only from the sweep of data collection when children's ages were closest to 5 years. In order to maximise comparability, I needed data collected on children at the same age. All datasets had sweeps when children were aged 4-6 years. I therefore used data from this sweep in the analysis (with a mean age as close as possible to 5 years).

In the NLSCY there were multiple cohorts of cross sectional samples within the dataset (see Appendix 5 for further detail). I included only the sample of 4-5 year olds from cohort 3 at cycle 5. This created a 'neat' sample for analysis, making it easier to use population weights. It also meant that data were collected in the same year as the other Canadian cohort (2003).

Exclusion criteria:

a) Children who did not take part in the sweep at age 4-6. This criterion was only relevant for the ECLS-K, in which large numbers of parents who did not provide data at this sweep were excluded.

b) Multiple births and siblings were excluded. This was in order to make samples comparable with the QLSCD, which included only singleton babies.

c) Children born outside the sample country (or region) were excluded. This was because the birth cohorts included only infants born in the country in which the cohort takes place. The LSAC-K cohort recruited children at kindergarten, therefore some children who were born outside Australia were sampled. These children were excluded to improve comparability. In the ECLS-K, children were also recruited at kindergarten, but data on country of origin was censored, so this exclusion could not be applied.

d) Children from ethnic minority groups in the country were excluded. This was a difficult decision because it led to large numbers of children being excluded in some countries, and there is a moral question about excluding all non-white children. However, I made this decision for four main reasons:

First, social gradients in health and development differ between the majority ethnic group and minority ethnic groups. This has been shown in numerous previous studies, e.g. for obesity (Ogden et al., 2010). I also conducted some exploratory analysis using MCS data, comparing social gradients in the whole sample, among white children in the sample and among children with non-white ethnicities in the sample (not reported). I found that social gradients were very marked among children with white ethnicities, but much less marked among children with non-white ethnicities. This may reflect the numerous influences of ethnicity on health and the implications of belonging to an ethnic minority group for social status. Therefore including children from ethnic minority groups would make interpretation of the role of socioeconomic position more complex. Although it would be interesting to explore these differences in gradients between ethnic groups, the relationship between ethnicity and health falls outside the focus of my thesis and sample sizes for some ethnic groups were small, making detailed analysis difficult.

Second, there are differences in the ethnic groups represented in the cohorts and the proportion of children from each ethnic group. Excluding children with non-white ethnicities enhanced the comparability of the samples.

Third, I had some concerns about the quality of the socioeconomic data for children from ethnic minority groups. Exploratory analysis of the MCS (not reported) showed that a higher proportion of households with children from non-white ethnicities had missing income data and missing education data or educational qualifications received overseas and not coded. Excluding children with non-white ethnicities reduced this bias.

Fourth, I had concerns that some of the outcomes were not appropriate or comparable for children from ethnic minority groups, especially verbal cognition.

Ethnicity was measured very differently in each cohort, so I had to use slightly different rules for excluding children from ethnic minority groups (summarised in Table 6-1 in chapter 6).

e) Finally, some children were excluded for analytic reasons. If they had been assigned a 0 weighting (reasons were not given for this in cohort documentation) they could not be included in weighted analysis, so were excluded. If there was a single sampling unit within a primary sampling stratum, STATA was not able to conduct survey (weighted) analysis, so children in these units needed to be excluded.

The numbers excluded at each stage of the sample selection process are summarised in chapter 6 (Table 6-1).

The within cohort samples therefore include: ***Singleton children aged 4-6 from the majority ethnic group who were born in the country in which the cohort took place.***

5.5. Harmonised variables

I developed harmonised variables for socioeconomic position, health and development outcomes and confounders. I first constructed tables to summarise the variables available in each cohort dataset, the question wording and response categories (summaries of these tables are presented later in this chapter and in Appendix 5). I used these tables to identify variables that could be harmonised across the cohorts.

It is important to note that data were collected face-to face in all cohorts, except the QLSCD, which used a telephone interview for the sweep of data used.

I identified differences and developed harmonised variables as described below:

Socioeconomic position variables

I have used household income and parental education level as indicators of socioeconomic position for the children. I have chosen these two indicators because they are available in all the datasets and can be harmonised for comparative analysis. I decided not to use parental occupation, due to problems with comparing occupation across countries and difficulty of classifying single mothers (discussed in chapter 3).

I chose to use socioeconomic position measured at the same time as the child outcome (4-6 years) to ensure consistency across the cohorts. Although including income measured at earlier points would allow consideration of duration and trajectories of income, this was not possible due to differences in timing of the first and subsequent sweeps of data collection.

Household income

I developed two income variables: 1) equivalised household income (continuous) and 2) quintiles of equivalised household income (ordinal, relative categories).

Household or family income was available in all the cohorts. However, household income was measured differently in each cohort. The following differences made income difficult to compare:

- Household income was measured before tax in the QLSCD, NLSCY, ECLS-K and the LSAC-K, but after tax in the MCS and Gen-R
- Income data were banded in the MCS, QLSCD, LSAC-K and Gen-R using different upper and lower bounds
- Income was measured in the local currency
- Household income when the child was aged 4-6 was collected at different years, meaning that there would be differences in prices due to inflation. There are also likely to be price differences across countries.
- Income data were not available for ABIS

Item non-response rates were also high for income data. In chapter 3 I identified four options for a harmonised income variable:

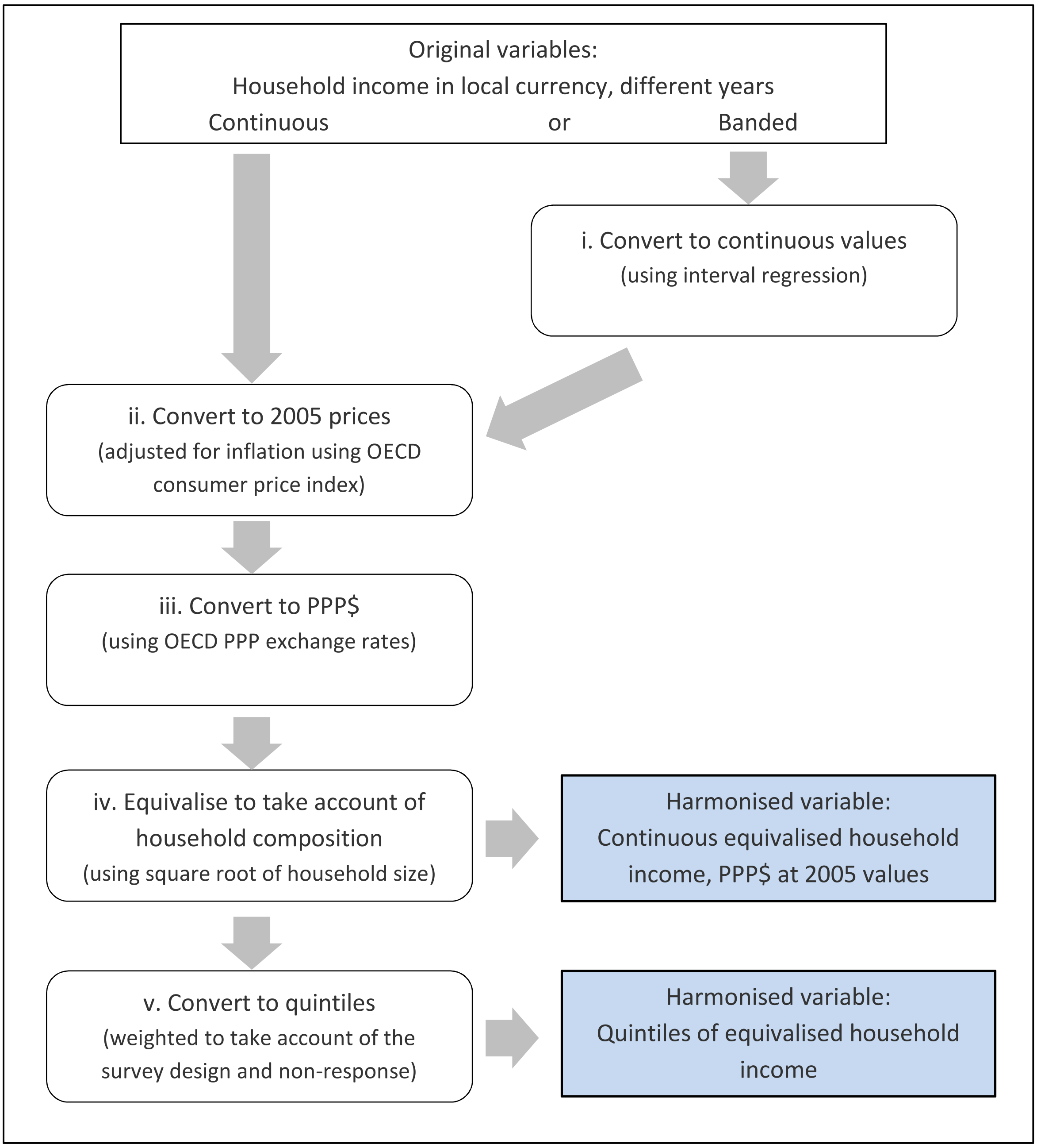
- Continuous household income (in country currency)
- Continuous household income (standardised, e.g. using PPP$ or scale 0-1)
- Absolute income categories (e.g. cut-offs at £10,000; £20,000 etc.)
- Relative income categories (e.g. using quintiles)

I decided to develop quintiles of income in order to present unadjusted statistics of child health and development by income quintile. Quintiles facilitate comparison between countries and graphs showing health and development by household income quintile can be easily understood. However, using quintiles aggregates the data, so that some of the detail of differences in incomes is lost. It also means that the absolute values are lost; therefore it is not possible to consider differences in the absolute levels of income in each cohort. Finally, quintiles of the sample may not represent quintiles in the population, due to sampling and attrition. For these reasons, I also developed a continuous income variable to use as a predictor in regression models to analyse the slope of the gradient, adjusting for confounders. I standardised income using PPP$ at 2005 prices in order to enhance comparability.

I developed the harmonised household income variables using the stages outlined in Figure 5-1. It was not possible to take account of differences in measuring income before or after tax (due to complexity of tax structure, depending on factors including the source of income, household composition). In order to harmonise gross and net income data, some projects have used publicly available calculators or developed programmes to estimate income before and after tax for each household in the study, e.g. (Burkhauser et al., 2001). However, this is a time-consuming process, very approximate and tools are not available for all my study countries. I therefore decided not to harmonise gross/net income between studies, but to consider the implications of these differences in the discussion, in line with other studies, e.g. (Mackenbach et al., 2005).

Further information on each of these stages is provided in Figure 5-1.

Figure 5-1: Development process for harmonised household income variables



i. I used interval regression models to assign income values within each income band, using the bounds of income bands as the dependent variables and a number of predictor variables (mother's age, mother's ethnicity, mother's education level, type of housing, region of residence). Although the simplest approach to conversion is assigning the mid-point of the band, this creates a very 'lumpy' variable (especially if bands are wide) and tends to understate income at the bottom end of the distribution and overstates it at the top end (Ketende and Joshi, 2008). Interval regression has the advantage that income values are 'spread' across the band. This technique also imputes values for missing income data (Ketende and Joshi, 2008). It does, however introduce some variability due to the addition of covariates to interval regression models. The details of this process and the components of the interval regression models are provided in Appendix 5. This step was not necessary for cohorts with continuous income data.

ii. The continuous household income values at different years were converted to 2005 prices. I used the OECD consumer price index figures to adjust for inflation in each country.

iii. The continuous household income at 2005 prices were then converted to PPP$ to aid comparison between countries. I used the OECD PPP$ exchange rates for 2005.

iv. Household income was equivalised to take account of the number and ages of people in the household, using the square root of the number of people in the household. Although the modified OECD equivalisation scale was preferable (as discussed in chapter 3), it was not possible to calculate this scale in the NLSCY, Gen-R or ECLS-K because data were not available on the ages of household members under 18. I therefore decided to use the square root scale in order to maximise comparability. These income values were used for the main analysis (regression models).

v. The final stage was to convert the income variable to quintiles of income. I used weighting when defining the quintiles, in order to take account of the survey sampling and attrition. The quintiles of income were used in the preliminary, unadjusted analysis.

Parental education

I developed a variable for the highest education level of either parent for each child with 4 absolute categories

As discussed in chapter 3, education is usually measured using years of education (continuous) or the highest qualification obtained (ordinal, categorised using ISCED or other categories). It was difficult to develop a continuous variable in a consistent way across the cohorts, due to differences in measurement and education systems. I therefore decided to develop an ordinal variable, based on the highest level of education or qualification achieved. This was easier to understand and more comparable between countries. The International Standard Classification of Education (ISCED) can be used to classify parental education, however in some cases there was insufficient detail in the cohorts to assign ISCED categories. I therefore modified the ISCED categorisation to create a more simplified variable with 4 categories.

Slightly different classifications were used for Group A/B cohorts and Group C cohorts. This is because the parents in ABIS and Gen-R were highly educated compared to the other samples – there were either none or very few parents without a secondary qualification. After discussion with people in the Netherlands and Sweden who work on these cohorts, we decided that having the lowest educational qualification had a similar conceptual meaning to having no secondary qualification in the other countries, in terms of status and chances of occupation. The categorisations are technically different, but they have a similar social meaning (discussed further in chapter 8). It should also be noted that the age that secondary schooling ended varied between the study countries. As I am interested in education as a marker of social position, I felt that this was not a major problem for the analysis, as a secondary qualification would have a similar social meaning. The classifications were therefore as follows:

Table 5-4: Parental education categorisation

Category	Highest parental education level in Group A and Group B cohorts	Highest parental education level in Group C cohorts
Category 1	Below secondary school qualification/not completed school	Completed secondary school qualification
Category 2	Completed secondary school qualification	Lower technical/vocational qualification
Category 3	Post-secondary or technical qualification	Higher technical/theoretical qualification
Category 4	Degree or higher qualification	Degree or higher qualification

Given the availability of data on education levels for the mother and father in all the cohorts, I was able to calculate the highest level of either parent. This had the additional benefit of reducing the amount of missing data (e.g. if mother's education level is not reported I used father's education level).

I recoded parental education variables in each cohort to the 4 categories, as detailed in Appendix 5. There were some differences in the timing of measurement of parental education. In ABIS, NLSCY, LSAC-K and ECLS-K parental education was measured at the sweep when the child was 5. In the QLSCD, a variable for parental education was available at age 5 which was developed from questions about education at age 3, followed by updates if parents obtained further qualifications. In the MCS, the education variable available at age 5 (NVQ qualification level) did not give sufficient detail to code to the four categories. I therefore calculated the highest qualification obtained over each sweep, using qualifications at 9 months and updates at further waves. In Gen-R I used education at child age 5, but filled missing data with parental education collected in previous sweeps.

There are also differences in which respondents are included in the parental education variables. In the QLSCD, data were collected from the natural mother and father (including natural fathers living in different households), therefore the parental education variables are for natural parents only (not including step fathers or other types of fathers). In other cohorts, data were collected from the main respondent or mother (natural parent in over 99% of cases in both cohorts) and from the main respondent's partner. The partner was the natural parent in the vast majority of cases (e.g. 93% of cases in the MCS and in 96% in the LSAC-K). Other main and partner respondent types included grandparent, foster parents, adoptive parents, step parents or unrelated adults.

For the purposes of generating the parental education variable I included only natural, step or adoptive parents. I made this decision as these three types of parents are likely to have long-term relationships with children and their education level is likely to be most relevant for the child's development.

Physical health and development outcomes

All outcomes were measured at age 4-6 years. I chose outcomes that were measured in a comparable manner across cohorts. I chose outcomes that represented each of the components of health and development identified in chapter 3: 4 indicators of physical health and development (height, overweight/obesity, excellent health, chronic illness), 2 indicators of socio-emotional development and mental health (hyperactivity and inattention, emotional problems and anxiety) and 1 indicator of cognitive development (verbal cognition).

Height

Height was measured by interviewers in the MCS, the LSAC-K, Gen-R and ABIS, and parent-reported in the ECLS-K. I have not included height data from the QLSCD or NLSCY due to very high rates of missing data (approximately 1/3 of children missed height data). I converted height to cm for analysis (continuous variable).

Overweight and obesity

Height and weight were measured and BMI was calculated in all cohorts. Height and weight were measured by interviewers in all cohorts, except the ECLS-K, where height and weight were parent-reported. The QLSCD and NLSCY were excluded from this analysis due to high rates of missing data.

I chose to compare the proportion above an overweight/obesity cut-off, because mean BMI can obscure problems of overweight and underweight in the population. In defining cut-off points for classifying children as overweight/obese, there are 2 questions: a) which reference population should be used; b) where should the cut-offs be set?

The set of standards developed by the Childhood Obesity Working Group of the International Obesity Taskforce are widely used in research on child weight (e.g. using the MCS (Hawkins et al., 2009)). Although the taskforce members acknowledge that the use of BMI is less sensitive than other measures, such as skinfold thickness, they note that BMI is a more widely available measure. The taskforce used data from an international survey of six large nationally representative cross sectional growth studies in order to develop height and weight 'norms'. The data were used to draw centile curves for BMI and age, by gender. These curves were then used to develop age and sex specific cut-off points for normal weight, overweight and obesity from 2-18 years (Cole et al., 2000).

I used zbmicat (a STATA add-on program) in order to categorise each child as normal weight, overweight or obese. This programme uses the Childhood Obesity Working Group of the International Obesity Taskforce cut-off points for BMI, taking the child's age and gender into account. The overweight and obese categories were then recoded into one combined category for analysis.

Excellent health

The child's overall health status was reported by the main respondent report in all cohorts. I developed a binary variable (excellent health: very good health or below). I chose to use excellent health for statistical reasons (the numbers of children with excellent health were quite high, there were very few with fair or poor health and analysis of this outcome had very wide confidence intervals). I also felt that it would be interesting to analyse a 'positive' health outcome, as I am already analysing poor health using the chronic illness variable, and previous analyses of social gradients in health have often focussed on ill health, rather than good health.

Table 5-5: General health status question wording in the cohorts

ECLS-K (US)	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Canada)	Gen-R (Neth)	ABIS (Sweden)
Would you say [CHILD]'s health is ... Excellent Very good Good Fair, or Poor?	In general would you say [name]'s health is .. 1 excellent, 2 very good, 3 good, 4 fair, 5 or, poor?	In general, how would you say child's current health is? 1 Excellent 2 Very good 3 Good 4 Fair 5 Poor	In general, would you say [name's] health is: 1 Excellent? 2 Very good? 3 Good? 4 Fair? 5 Poor?	In general, would you say [name's] health is: 1 Excellent 2 Very good 3 Good 4 Fair 5 Poor	How would you describe the general state of your child's health? Excellent Very good Good Moderate Bad	Not collected

Note: questions in the QLSCD and Gen-R are translated to English

The question wording was very similar across the studies, with the same response categories (Table 5-5). However, there may be differences in subjective reporting of health status between countries and by socioeconomic position. The implications of this for interpretation of findings are discussed in the chapter 8.

Chronic illness

Whether the child had a chronic condition was measured by parental/main respondent report in all three cohorts.

The question wording in each cohort is detailed in Table 5-6. There are some differences in how chronic conditions were measured between the cohorts, which are likely to have implications for the reported frequency of chronic conditions. ABIS did not include an overall question on chronic illness, so the variable was constructed from responses to a series of questions on individuals. In all the cohorts except ABIS, a time period was specified (6 months or long period of time); in ABIS the question wording did not mention the time period, therefore some acute, short-term conditions may be included. In the MCS and LSAC, respondents were first asked if the child had a chronic condition, followed by further specific questions on illnesses that the child had. In the QLSCD the question was asked in reverse, starting with questions on a number of specific chronic conditions, followed by an overall question on whether the child has any chronic conditions. It is possible that this structure may prompt parents to recall more chronic conditions, making them more likely to say that their child has a chronic condition. These differences are discussed in relation to interpretation of the findings in chapter 8.

Table 5-6: Chronic illness question wording in the cohorts

ECLS-K (US)	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Canada)	Gen-R (Neth)	ABIS (Sweden)
Not collected	Does [name] have any longstanding illness, disability or infirmity? By longstanding I mean anything that has troubled [name] for a period of time or is likely to affect [name] over a period of time. (Followed by questions on specific illnesses)	Does Study Child have any medical conditions or disabilities that have lasted or are likely to last for six months or more? Followed by listing of specific conditions	In the following questions long-term conditions refer to conditions that have lasted or are expected to last 6 months or more and have been diagnosed by a health professional. Has a health professional diagnosed any of the following long-term conditions for [name]: (list of long-term conditions)	In the following questions long-term conditions refer to conditions that have lasted or are expected to last 6 months or more and have been diagnosed by a health professional (a doctor). Does [name] have any of the following long-term conditions: (list includes any chronic conditions)	Not collected	Series of questions on individual conditions: Asthma Allergy symptoms Diabetes Gluten intolerance Rheumatic arthritis Rheumatic eye inflammation Crohns disease Ulcerative collitis Psychiatric problems Other serious disease/handicap

Socio-emotional development and behaviour outcomes

Child behaviour was measured using parental report using the Strengths and Difficulties Questionnaire (SDQ) in the MCS and the LSAC-K, the Child Behavior Checklist (CBCL) in Gen-R and a specific scale developed in both Canadian cohorts. I chose two domains for comparative analysis: emotional problems/anxiety and hyperactivity/inattention. These two domains were the most comparable - they had items that were very similar across the different scales. Response options to items are similar across the SDQ, Canadian cohorts and CBCL checklist. These separate domains of child behaviour were not assessed in the ECLS-K.

Emotional problems and anxiety

In the NLSCY and QLSCD the items on emotional problems and anxiety were very similar to the SDQ, with some additions. I therefore revised the emotional problem/anxiety domain in the Canadian cohorts by excluding items that were very different from the SDQ, and created a summary score using the same methods used to develop SDQ domain scores. The CBCL checklist DSM depression scale also included very similar items.

I standardised the scores around mean=0, sd=1 to improve comparability between cohorts. This does not create perfectly comparable scores – each scale has measured emotional problems and anxiety slightly differently, and the revised scales for the Canadian cohorts have not been validated. However, it does allow some comparison. This approach has been used in previous cross-national comparisons of cohort studies (Bradbury et al., 2010). The components of the emotional problem and anxiety scores are scales in Table 5-7.

Table 5-7: Emotional problem and anxiety scale components in the cohorts

MCS (UK)	ECLS-K (US)	LSAC-K (Australia)
SDQ Emotional symptoms scale • Often complains of headaches, stomach aches or sickness • Many worries or often seems worried • Often unhappy, depressed or tearful • Nervous or clingy in new situations, easily loses confidence • Many fears, easily scared	Not collected	SDQ Emotional symptoms scale • Often complains of headaches, stomach aches or sickness • Many worries or often seems worried • Often unhappy, depressed or tearful • Nervous or clingy in new situations, easily loses confidence • Many fears, easily scared

NLSCY (Canada)	QLSCD (Quebec)	Gen-R (Netherlands)	ABIS (Sweden)
Emotional disorder and anxiety • Is worried? • Seems to be unhappy or sad? • Cries a lot? • Is nervous, high-strung or tense? • Is too fearful or nervous?	Emotional disorder and anxiety • Was worried? • Seemed to be unhappy or sad? • Cried a lot? • Was nervous, highstrung or tense? • Was too fearful or anxious?	CBCL checklist DSM anxiety problems scale (individual items not reported due to copyright)	Not collected

Hyperactivity and inattention

Hyperactivity and inattention was measured using the SDQ in the MCS and the LSAC, the CBCL checklist in Gen-R and a specific scale in the Canadian cohorts. The SDQ hyperactivity domain was therefore used in these cohorts. The SDQ was not used in the QLSCD, but questions were posed on hyperactivity and inattention, which were very similar to questions posed as part of the SDQ and were scored in the same way. I therefore identified questions that had a similar meaning to the questions asked in the SDQ and created a summary score using the same methods used to develop SDQ domain scores. I standardised the scores around mean=0, sd=1 to improve comparability between cohorts. The components of the hyperactivity scores in each cohort are show in Table 5-8.

Table 5-8: Hyperactivity and inattention scale components in the cohorts

MCS (UK)	ECLS-K (US)	LSAC-K (Australia)
SDQ Hyperactivity scale • Restless, overactive, cannot stay still for long • Constantly fidgeting or squirming • Easily distracted, concentration wanders • Thinks things out before acting • Good attention span, sees chores or homework through to the end	Not collected	SDQ Hyperactivity scale • Restless, overactive, cannot stay still for long • Constantly fidgeting or squirming • Easily distracted, concentration wanders • Thinks things out before acting • Good attention span, sees chores or homework through to the end

NLSCY (Canada)	QLSCD (Quebec)	Gen-R (Netherlands)	ABIS (Sweden)
Hyperactivity and inattention • Can't sit still or is restless? • Can't concentrate, can't pay attention for long? • Is easily distracted, has trouble sticking to any activity? • Is impulsive, acts without thinking? • Cannot settle on anything for more than a few moments?	Hyperactivity and inattention • Could not sit still, was restless or hyperactive? • Was unable to concentrate, could not pay attention for long? • Was easily distracted, had trouble sticking to any activity? • Was impulsive, acted without thinking? • Couldn't settle down to do anything for more than a few moments?	CBCL checklist DSM hyperactivity problems/ inattention scale (individual items not reported due to copyright)	Not collected

Cognitive development outcomes

Verbal cognition

A number of different tools were used to measure different aspects of cognitive development in the cohorts. Many of these were quite different, so could not be compared. However, verbal cognition was measured in 3 cohorts, using picture recognition approaches. I therefore chose this outcome for comparative analysis. In the MCS, verbal cognition was measured using the British Ability Scale, in which children are shown a picture and asked to say its name. In the LSAC-K and the NLSCY, verbal cognition was measured using the Picture Peabody Vocabulary Test (PPVT) (different versions, but using the same approach), in which children are told a word and asked to point to the picture that the word describes. Both of these tests measure knowledge of the meaning of spoken words.

Scoring systems and the range of scores differed between the BAS and PPVT. I therefore standardised scores for comparative analysis. I standardised the raw total scores that were unadjusted for age, so that I could analyse the role of age myself.

Other variables

Child age

I developed a comparable child age variable for use in the main (multivariate) analysis. I converted child age variables in all cohorts to months for comparability across countries.

Child sex

Child sex was available in all cohorts and used in preliminary and multivariate analysis.

5.6. Analysis

There were three stages to the analysis:

i. Descriptive statistics
ii. Preliminary (bivariate) analysis of the social gradient
iii. Main (multivariate) analysis of the social gradient

All analyses were conducted using STATA 11. Where possible, I weighted the analysis to take account of the initial sampling strategy and attrition. This facilitates inference to the population that the sample aims to represent. In the ECLS-K, MCS and the LSAC, this was achieved using the svy commands (taking account of sampling strata and units and weights), which also take account of clustering due to the sampling strategy (the standard errors are adjusted to take account of clustering). In the QLSCD and NLSCY, variables on the sampling strata were not available, so I used weighting for the analysis (but could not use svy commands to take account of clustering – this means that standard errors may be slightly under-estimated). In Gen-R and ABIS, no weighting variables were available, so all analysis was unweighted.

I analysed the extent of missing data, and whether children from more deprived social backgrounds were more likely to have missing data. There are a number of options for dealing with missing data, including complete case analysis (dropping cases with missing data), single and multiple imputation. Where the rate of missing data is low (10%), these approaches lead to similar findings (Langkamp et al., 2010). As the rates of missing data were low in the initial cohorts that I analysed, I decided to conduct a complete case analysis of the data, and not to impute missing values in the datasets. This may have slightly affected the study power. It is also likely that estimates from my analysis are slightly biased – however rates of missing data were generally very low, so this should not be a large problem. I have discussed this decision further in Chapter 8.

In the analysis, associations were generally considered significant at the p<=0.05 level; however interpretations of models also take the number of observations and power into account. For decisions about whether to include second-order terms in the models (interaction and squared terms), I used a cut-off at p<=0.1. This was to ensure sensitivity to interactions and curvilinear patterns, which could be missed at lower significance levels.

i. Descriptive statistics

I first calculated descriptive statistics to summarise the variables within each country dataset. This allows us to consider the similarities and differences between the samples, and the potential reasons for these differences (e.g. 'real' differences or artefactual differences due to variation in methods).

I present these statistics in chapter 6. This includes an overview of the demographics of children in the sample, in terms of age and sex distribution, and descriptive statistics for the SEP variables. I present the mean and distribution of child height and behaviour and cognition scores, and the frequencies of overweight/obesity, excellent health and chronic illness. Descriptive statistics presented are weighted where possible; tables of both unweighted and weighted descriptive statistics are presented in Appendix 6.

ii. Preliminary bivariate analysis

I conducted preliminary analysis of the social gradient in child health and development by presenting child outcomes by categories of SEP (parental education categories and income quintiles). I presented unadjusted means for continuous outcomes and rates for binary outcomes. I analysed gradients for boys and girls separately and conducted separate analyses for each cohort (weighted where possible). I present the social gradients using bar charts to provide a first indication of the social gradient in each cohort (weighted and unweighted figures are provided in tables in Appendix 7).

iii. Multivariable analysis of the social gradient

I used weighted least squares regression (for continuous outcomes) and weighted logistic regression (for binary outcomes) to analyse the social gradient. Separate models were run to regress the outcomes on parental education categories and on continuous equivalised household income (PPP$ at 2005 prices); models included child age and sex. In most cohorts, the distribution of equivalised household income deviated considerably from a normal distribution, so I log-transformed it for analysis. The income distribution was closer to normal in the QLSCD (due to top-coding of high incomes) – log transforming made little difference to deviation from normality. I chose to log-transform in all cohorts, in order to maintain comparability between cohorts. Separate models were run for each cohort.

I kept age and sex in the models, even if these terms were not significant, in order to maintain comparability. I explored whether there was an interaction between household income or parental education and child sex in the models (i.e. whether there were differences in social gradients for boys and girls). In the models to assess household income, I also explored the addition of a squared income term to the model (i.e. whether the gradient was curvilinear). It is not possible to conduct Likelihood Ratio tests to compare the models when using survey weighting in STATA. I therefore kept the interaction and squared terms in the models if they were significant (at $p<=0.1$). I used a z-test to test for overall significance of interactions including categorical variables.

I presented the estimates from the models in tables. However, it is difficult to draw comparisons between the findings from each cohort. In the logistic regression models, findings are presented as odds ratios, which can be difficult to compare because they are affected by the frequency of the outcome in the sample (chapter 3 includes discussion of the drawbacks of using odds ratios and other relative measures of inequality for comparisons between countries). The gradient by household income is difficult to compare for several reasons. Household income is equivalised and log transformed, so is difficult to comprehend. Also, interactions and squared terms were included in some models and cohorts, but not others, creating further complications for comparisons.

I therefore predicted outcomes from the models, in order to visualise the social gradients and to present social gradient in a comparable manner across cohorts. I calculated predicted probabilities (from logistic regression models) and predicted values (from least squares regression models) for children with particular age, sex and socioeconomic characteristics. This enabled me to predict the health and development outcomes for children in exactly the same circumstances in each cohort. This is very useful for drawing comparisons across the countries, as it removes differences, e.g. in child age between the cohorts. I predicted outcomes separately for girls and boys aged exactly 5 years with parents in each educational category. I also predicted outcomes for girls and boys aged exactly 5 years, living in a 2 parent, 2 child household, with incomes at the following percentiles in the income distribution: 5^{th}, 25^{th} 50^{th} (median), 75^{th} 95^{th}. I presented the predicted values and probabilities and confidence intervals in separate graphs for boys and girls from each cohort.

A key limitation was that the diagnostic and post estimation tests for the regression analyses are not available following weighted regression in STATA. I was therefore unable to run model diagnostics. This is discussed further in Chapter 8.

Analysis of social gradients

In Chapter 3 I outlined the 5 features of the social gradient: level, slope, significance, length and curvilinearity. My research questions focus on comparisons of the length and slope in order to achieve the thesis aim. The bivariate and multivariate analysis allowed comparison of the slope. Predictions from the multivariate regression models allowed comparison of the level, after taking age and sex differences into account.

I also took account of the other 3 features of the gradient throughout the analysis. I assessed the significance of the gradient in multivariate regression models using the p-values (also taking limitations due to sample size into account). The length of the income gradient was also considered and discussed in chapter 8; it was not possible to compare the length of the parental education gradient (as absolute categories of education were used). It was difficult to assess curvilinearity - equivalised household income was log transformed in regression models; squared terms were included where significant.

5.7. Summary of chapter 5

This chapter provided a background to harmonisation of datasets for the comparative cohort analysis. It also gave an overview of the methods used in the comparative cohort analysis.

1) Studies are increasingly harmonising cohorts to generate comparative findings. There are a number of differences between cohort datasets that need to be taken into account, in terms of: sampling and response, other design issues, measurement differences, context and history, and data management. It is important to harmonise datasets in order to minimise this heterogeneity. This helps to ensure that comparative findings reflect real population differences.
2) I compared data from 7 cohort studies in 6 countries. The cohorts were divided into groups according to national income inequality level: Group A- high inequality (MCS and ECLS-K), Group B – medium inequality (LSAC-K, NLSCY, QLSCD) and Group C – low inequality (Gen-R and ABIS). Within each cohort, I selected comparable samples of 4-6 year olds for analysis.
3) I harmonised SEP variables (parental education and household income) and child health and development outcomes (height, overweight and obesity, general health status, chronic conditions, emotional problems and anxiety, hyperactivity and inattention and verbal cognition). Some differences remain which need to be taken into account in interpretation.
4) I conducted analysis of social gradients in STATA 11, using weighting variables. There were 3 stages to analysis: descriptive statistics of the sample and variables, preliminary bivariate analysis and final regression analysis, controlling for age and sex. I predicted expected outcomes for children in different socioeconomic circumstances, using regression models in each cohort. This allows us to compare children in the same circumstances in each cohort.
5) Findings are presented using graphs, where possible (in chapters 6 and 7), with additional tables in Appendix 7.

Chapter 6: Comparative cohort analysis - Descriptive statistics

This chapter presents an overview of the children from each cohort study included for analysis. Summary statistics are presented for the children and their households, socioeconomic position and child health and development outcomes.

6.1. Introduction

This chapter provides a summary of the samples of children selected for analysis. Samples of children aged 4-6 were selected from each cohort study. Summary statistics are presented on the cohort children and their households, their socioeconomic position (parental education levels and household income) and their health and development outcomes (height, overweight and obesity, excellent health, chronic illness, emotional problems and anxiety, hyperactivity and inattention, verbal cognition). Histograms are also presented to compare the distribution of each variable in each cohort sample. Statistics are presented by income inequality group and cohort and comparisons are drawn.

As far as possible, statistics presented in this chapter are weighted to reflect the population represented by each cohort sample (in the MCS, ECLS-K, LSAC-K, NLSCY and QLSCD). In Gen-R and ABIS, statistics are unweighted, as weighting variables were not available. More detailed tables containing both unweighted and weighted statistics are presented in Appendix 6. Statistics are rounded to 1 decimal place, except standardised scores, which are rounded to 2 decimal places. In the NLSCY, all statistics are rounded to 1 decimal place, in accordance with Statistics Canada's rounding rules. Histograms showing the frequency distributions of variables in the samples are unweighted.

6.2. Sample selection and size

The final sample sizes included in analyses range from 1,612 in the QLSCD to 12,523 in the MCS. The exclusion criteria and the number of children excluded at each stage in each sample are summarised in Table 6-1.

Table 6-1: Exclusion process and sample sizes

	MCS (UK)	ECLS-K (US)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Canada)	Gen-R (Rotterdam)	ABIS (Sweden)
Preliminary sample at age 4-6:	15,460	21,409	4,983	6,126 (age 4-6 from cohort 3 at cycle 5, out of total sample 30,611 in cycle 5)	1,759	6,175 (age 4-6 children only)	7,445
Exclusions:							
Missing parent interview (age 5)	-	4,491 excluded	-	-	-	-	-
Multiple births/ siblings	214 twins/triplets excluded	414 twins/triplets excluded	141 twins/triplets excluded	269 twins/triplets excluded	-	148 twins/triplets excluded 368 siblings excluded (1 child per household retained, selected randomly)	129 twins/triplets excluded
Born outside sample country/ province	-	0 (data not available)	202 excluded	-	-	-	-
Ethnic minority status	2,519 excluded (children identified as non-white by main respondent)	6,983 excluded (children identified as non-white by parent)	395 excluded (m and f born outside of N. America/Europe/Australia/ New Zealand)	608 excluded (children identified as non-white by main respondent - CHECK)	147 excluded (children with ethnicity=African/ Amerindian/other)	2,027 (children with ethnicity that is not European or American(western))	146 excluded (mother and father's country of origin is not Sweden)
Survey structure/ weighting	-	25 excluded	2 excluded	2 excluded	-	-	-
Final sample for analysis	12,523	9,495	4,243	5,267	1,612	3,632	7,170

A particularly large proportion of the sample was excluded in the ECLS-K and Gen-R samples. In the ECLS-K this was largely due to the large number with no parental interview data (and therefore no socioeconomic position or child health/development outcome data) and large number of children from minority ethnic groups; in Gen-R this was largely due to the large number of children from minority ethnic groups.

6.3. The cohort children and their households

Age and sex

The ages and sex of children are summarised in Table 6-2. The mean age of children ranged from 57 months (4¾ years) in the LSAC-K to 73 months (over 6 years) in the Gen-R sample. The ECLS-K and NLSCY samples have the most variance in children's ages (shown in histograms in

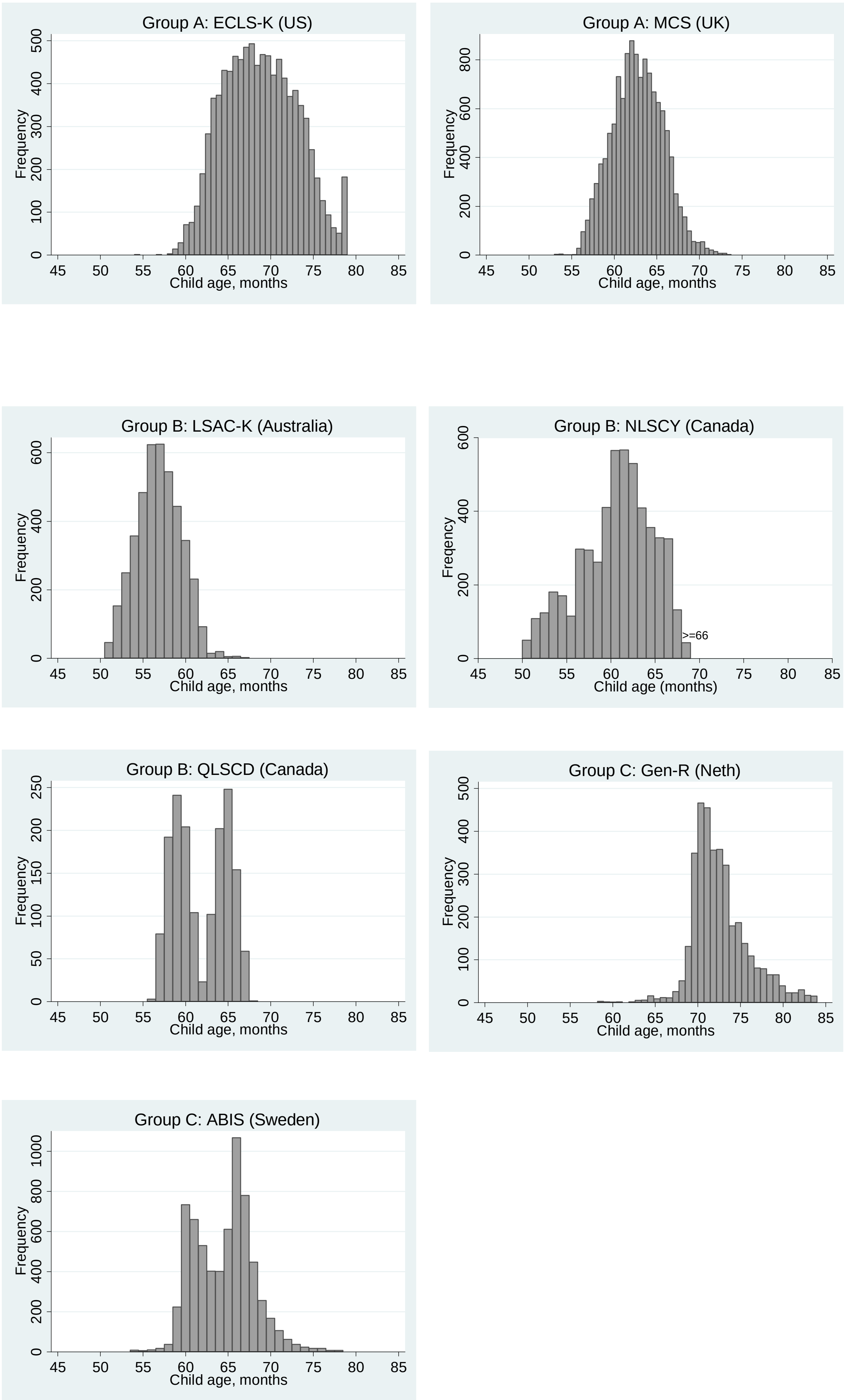
Figure 6-1). All sample age ranges included 60 months, the point at which predicted outcomes were calculated from regression models in chapter 7. However we should note that 60 months lies at the left hand tail of the age distribution in the ECLS-K and Gen-R. The ratio of girls:boys was similar across the cohorts.

Table 6-2: Age and sex of children, by group and cohort

	Group A		**Group B**			**Group C**	
	ECLS-K (US)	**MCS (UK)**	**LSAC-K (Australia)**	**NLSCY (Canada)**	**QLSCD (Canada)**	**Gen-R (Neth)**	**ABIS (Sweden)**
Age (months)							
mean	68.8	62.6	57.0	58.2	61.7	72.6	64.5
sd	4.3	2.9	2.6	4.1	3.1	3.3	3.5
range	54:79	53:74	51:67	48: >=65	56:68	58.2:84.0	54:78
Sex							
girls	48.0%	48.8%	48.7%	48.7%	50.7%	50.6%	47.5%
boys	52.0%	51.2%	51.3%	51.3%	49.3%	49.4%	52.5%

* age groups have been aggregated in the age range to comply with Statistics Canada reporting rules

Figure 6-1: Age distribution of children in the samples



Household composition

Household composition was similar across the cohorts (Table 6-3). The majority of children lived in households with two adults (77.7-81.8%). A slightly higher proportion of children lived in households with a single adult in the MCS (16.5%), compared with other cohorts. There was variation in the number of children in the household; approximately half of children lived in households with two children.

Table 6-3: Children's household composition, by group and cohort

	Group A		Group B			Group C	
	ECLS-K (US)	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Canada)	Gen-R (Neth)	ABIS (Sweden)
Number of adults							**Lone/couple parent**
1	10.9%	16.5%	11.0%	12.9%	13.3%	13.2%	Lone: 6.6%
2	80.2%	78.2%	77.7%	81.8%	77.7%	85.3%	Partner: 93.4%
3	6.7%	4.4%	7.6%	3.5%	6.6%	1.2%	
4+	2.1%	0.9%	3.8%	1.8%	2.5%	3.3%	
Number of children							**Number of siblings**
1	15.5%	17.0%	12.6%	18.1%	18.1%	19.0%	0: 6.5%
2	47.3%	50.7%	50.7%	53.5%	56.1%	56.2%	1: 56.3%
3	26.3%	22.6%	26.6%	20.6%	20.3%	21.4%	2: 26.1%
4+	10.9%	9.8%	10.0%	7.8%	5.5%	3.4%	3: 11.1%

6.4. Socioeconomic Position

Parental education

Parental education was measured as the highest level achieved by either parent. There was some variation in the distribution of highest parental education between the samples (summarised in Table 6-4 and Figure 6-2). The reasons for these differences and their implications for interpretation of gradients are discussed in chapter 8.

A small proportion of children had parents who had not completed secondary school. This was the case for 13.7% of children in the MCS, 7.9-9.9% of children in the LSAC-K, NLSCY and QLSCD, and only 3.8% in the ECLS-K. This low proportion in the ECLS-K probably reflects the sampling approach for the cohort, rather than true differences between the countries (sampling was from kindergartens and private schools were oversampled).

A large proportion of parents in the UK completed secondary school but did not achieve further post-secondary or technical qualifications (secondary school was the highest parental qualification for 42.3% of children). Post-secondary or technical qualifications were the highest parental qualification for only 11.1% of children in the MCS. In the other cohorts, by contrast, a higher proportion of children had at least one parent who had achieved post-secondary or technical qualifications (ranging from 34.4% in LSAC-K to 39.0% of children in the QLSCD). Therefore there were fewer children in the secondary parental education category in these cohorts (the proportion of children with parents with secondary level education ranged from 16.7% of children in the QLSCD to 25.6% in the LSAC-K). A similar proportion of children had at least one parent with a degree or higher across the cohorts (31.9-35.9%).

Different categories with similar social meanings were used in ABIS and Gen-R, as discussed in chapter 5. There were very few children with parents in the bottom education category (secondary qualification) in both of these samples (2-5%). A very high proportion of children (almost 50%) had at least one parent educated to degree level.

In the QLSCD sample, there are only 132 children in the less than secondary parental education category, due to the small proportion in this category and the small cohort sample size. This has implications for estimates in chapter 7 (further discussed in the discussion in chapter 8).

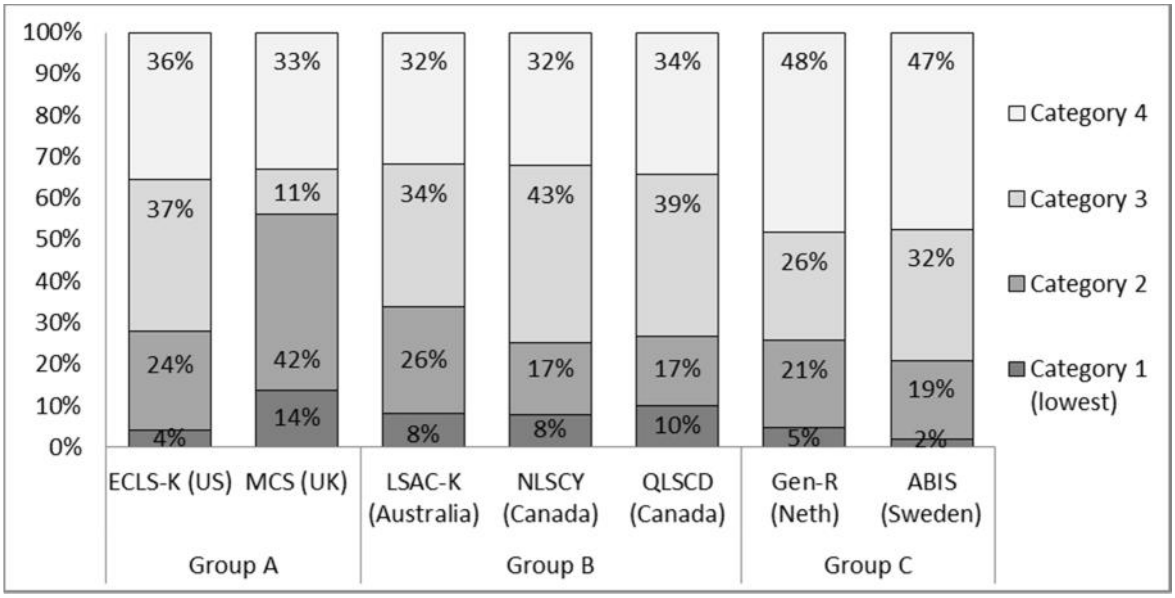
Missing data rates were very low for parental education. This is partly because levels of missing data were low for this variable. It was also due to the definition of the variable as the highest education of either parent, so if one parents' education was missing, the other parent's education was used instead.

Table 6-4: Summary of parental education levels, by group and cohort

	Group A		Group B		
	ECLS-K (US)	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Canada)
Highest parental education level					
Category 1 (below secondary)	3.8%	13.7%	8.1%	7.9%	9.9%
Category 2 (secondary qualification)	23.5%	42.3%	25.6%	17.3%	16.7%
Category 3 (post-secondary/technical)	36.9%	11.1%	34.4%	42.8%	39.0%
Category 4 (degree or higher)	35.9%	32.9%	31.9%	32.0%	34.4%
Number missing education data (%)	0	175 (1.4%)	20 (0.5%)	0	114 (3.1%)

	Group C	
	Gen-R (Neth)	ABIS (Sweden)
Highest parental education level		
Category 1 (secondary qualification)	4.8%	2.0%
Category 2 (lower technical/vocational)	21.1%	18.9%
Category 3 (higher technical/theoretical)	25.8%	31.6%
Category 4 (degree or higher)	48.4%	47.5%
Number missing education data (%)	112 (3.0%)	65 (0.9%)

Figure 6-2: Proportion of children in each parental education category, by group and cohort



Household income

Table 6-5 summarises the distribution of household income in PPP$ at 2005 prices, and equivalised to take account of household composition in PPP$ at 2005 prices. The distribution of household income in local currencies at the year of data collection is presented in Appendix 6. The distribution of household income (in PPP$ at 2005 prices) is shown in histograms in Figure 6-3.

The mean household income varied considerably between cohorts. Mean income was lowest in the MCS (PPP$ 41,823) and highest in the ECLS-K (PPP$ 69,570). There was also considerably higher variance in household income in the ECLS-K than the other cohorts. The range of household incomes for children in the samples also varied. Income values ranged as low as PPP$ 0 per year in the ECLS-K and NLSCY, but not in other cohorts. The top income values were considerably higher in the ECLS-K and lower in Gen-R than other cohorts.

These variations are likely to reflect a number of differences in measurement and sampling between the cohorts. Income was measured before tax in all cohorts except the MCS and Gen-R (therefore MCS and Gen-R incomes are lower than they would be if they had been measured before tax, as in other cohorts). Income data in the ECLS-K and NLSCY were continuous, with tails at the top end of the income distribution. As discussed in chapter 5, the MCS, LSAC-K and QLSCD had collected income in bands, with top-coding of high incomes into a top category. Although interval regression spread these values out, and high incomes were truncated in the NLSCY and ECLS-K, this difference contributed to the higher income values at the top end of the distribution in the ECLS-K and NLSCY. Differences in sampling may also have played a role, in particularly over-sampling of children from private schools in the ECLS-K. The implications of these differences for comparisons of gradients in child health and development are considered in chapter 8.

Some of the cohorts also have ‘peaks’ at the top of the income distribution. This is due large number of households in the top income category in the MCS and LSAC-K and due to truncation of household incomes to improve comparability in the ECLS-K and NLSCY.

After equivalisation to take account of household composition, a similar pattern was evident. Mean equivalised household income was lowest in the MCS and highest in the ECLS-K and variance was highest in the ECLS-K.

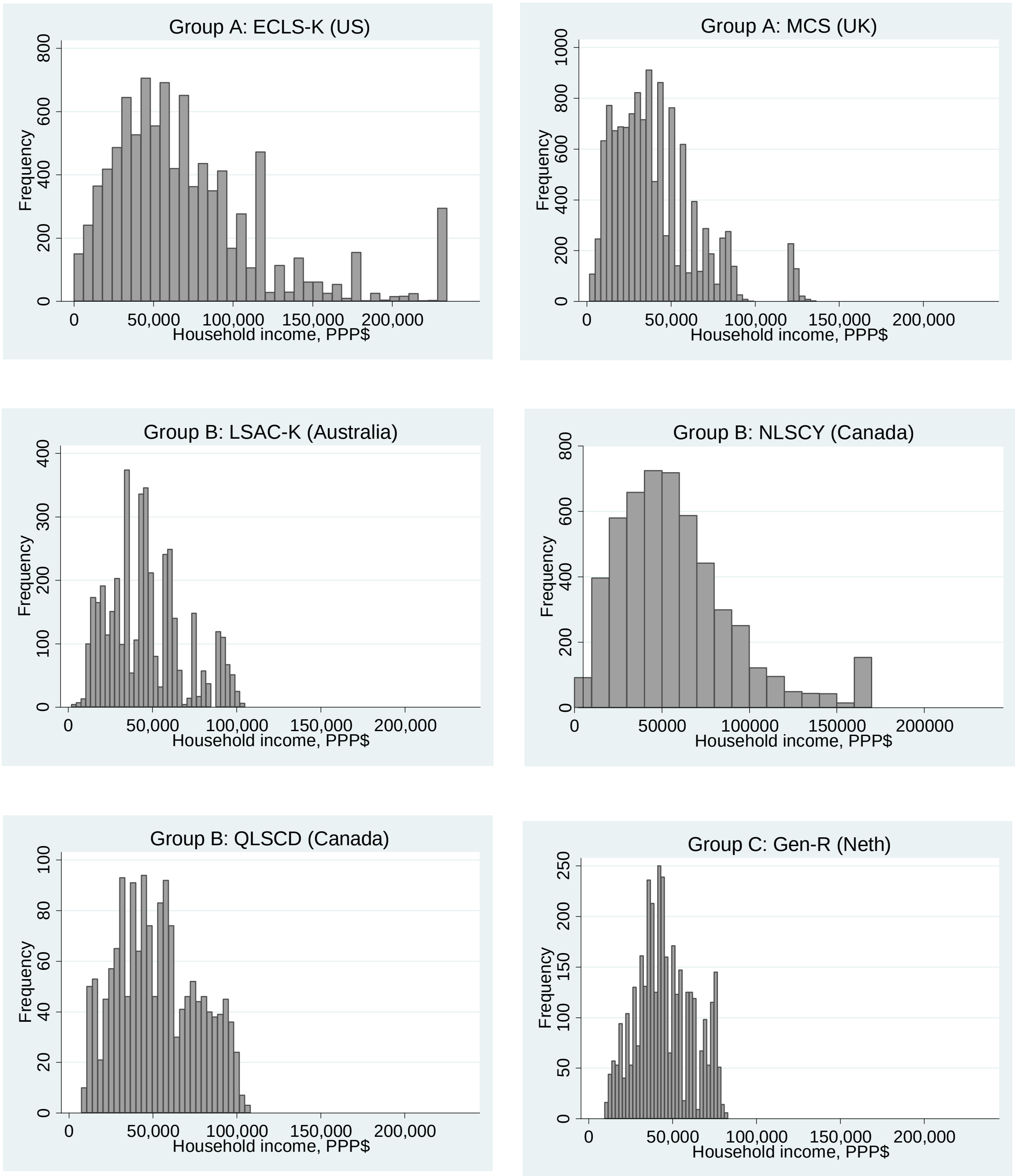
Table 6-5: Summary of children’s household income, by group and cohort

	Group A		**Group B**			**Group C**	
	ECLS-K (US)	**MCS (UK)**	**LSAC-K (Australia)**	**NLSCY (Canada)**	**QLSCD (Canada)**	**Gen-R (Neth)**	**ABIS (Sweden)**
Household income (2005 PPP$)							
mean	69,570	41,823	44,958	58,100	50,541	46,172	Not available
sd	48,309	26,163	22,182	33,900	24,087	17,092	
median	58,620	36,428	43,540	52,600	47,353	44,281	
range	0: 234,479	1,574: 136,272	1,823: 104,655		7,325: 107,995	9,676: 84,596	
Equivalised household income (2005 PPP$)							
mean	33,722	20,609	21,674	28,700	25,097	23,449	
sd	23,247	12,703	10,851	16,400	11,947	8,395	
median	29,106	18,015	20,320	25,600	23,696	22,640	
range	0: 165,802	643: 77,937	911: 61,895		3,662: 62,351	4,365: 57,475	
Number missing equivalised income (%)	0	162 (1.3%)	140 (3.3%)	0	63 (3.9%)	315 (8.7%)	

Note: ranges are not presented for the NLSCY, in compliance with Statistics Canada reporting rules

Missing data rates were low in all cohorts except in Gen-R. Missing data is often a problem for income data (discussed in chapter 3). In the NLSCY and ECLS-K there was no missing data because missing income data had been imputed before data release. In the other cohorts, interval regression minimised missing data.

Figure 6-3: Distribution of household income (PPP$ at 2005 prices) in the samples (unweighted)



Note: income data from the NLSCY are weighted and have been aggregated in histograms to comply with Statistics Canada reporting regulations.

6.5. Child health and development outcomes

Height

Table 6-6 and Figure 6-4 show the distribution of child height in the samples. Children were shortest, on average, in the LSAC-K (108.5cm) and tallest in Gen-R (118.9cm). As height is closely related to child age, this difference reflects differences in mean age in the samples. Boys were approximately 1cm taller than girls in all cohorts. Height was excluded from analysis in the NLSCY and QLSCD due to very high rates of missing data (approximately 1/3 of the sample had missing height data in both cohorts). Height was normally distributed in each cohort (Figure 6-5). Missing data rates were low in all samples.

Table 6-6: Summary of children's height, by group and cohort

	Group A		Group B			Group C	
	ECLS-K (US)	**MCS (UK)**	**LSAC-K (Australia)**	**NLSCY (Canada)**	**QLSCD (Canada)**	**Gen-R (Neth)**	**ABIS (Sweden)**
Height (cm)				Excluded	Excluded		
Total sample:							
mean	113.6	110.6	108.5			118.9	114.1
sd	5.4	4.9	4.7			5.2	5.2
range	88.9: 152.4	89.9: 131.0	93.0: 125.5			101.3: 136.7	95.0: 140.0
Girls: mean	113.0	110.1	108.0			118.5	113.6
sd	5.4	4.9	4.7			5.3	5.1
Boys: mean	114.2	111.0	109.0			119.2	114.5
sd	5.4	4.9	4.7			5.2	5.2
Number missing height data (%)	212 (2.2%)	167 (1.3%)	33 (0.8%)			8 (0.2%)	143 (2.0%)

Figure 6-4: Mean height for children, by group and cohort

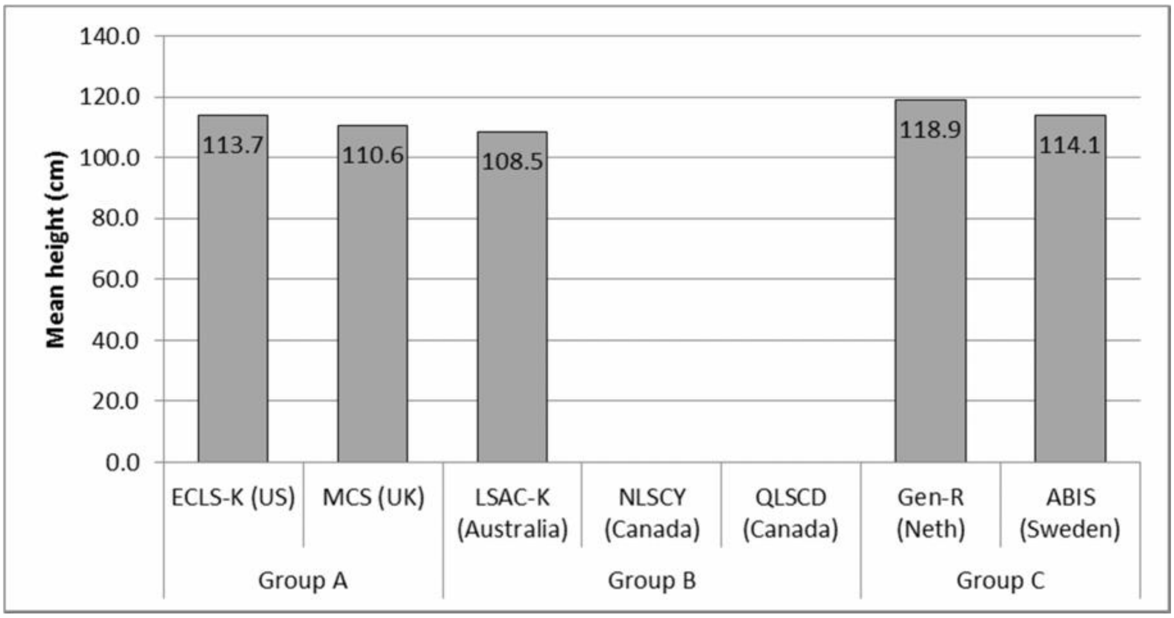
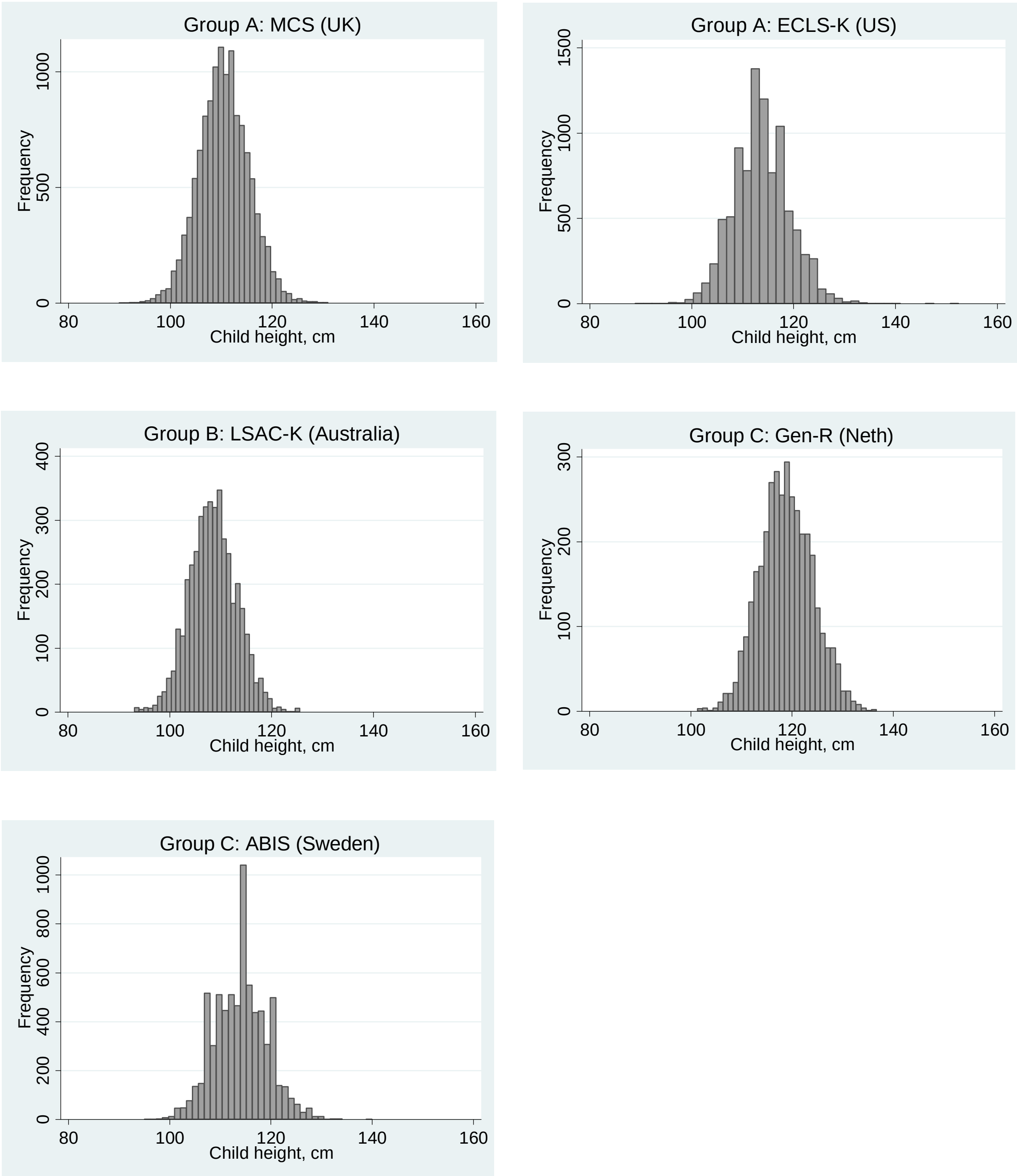


Figure 6-5: Distribution of child height in the samples



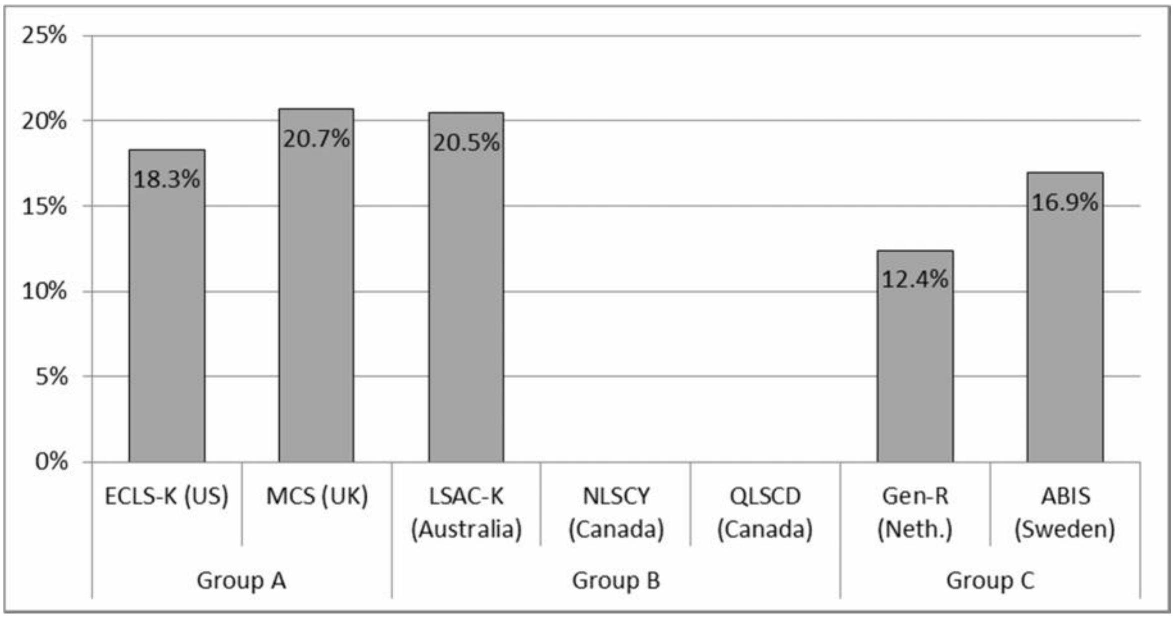
Overweight and obesity

Table 6-7 and Figure 6-6 show the proportion of children who are overweight or obese in the samples. Children in the MCS and LSAC-K were most likely to be overweight or obese (20.7% and 20.5% respectively). In comparison, only 18.3% of children in the ECLS-K were overweight or obese. This finding is surprising, given previous research on overweight and obesity, and may reflect the sampling strategy in the ECLS-K. This issue is further considered in the discussion in chapter 8. Overweight/obesity was least prevalent overall in Gen-R. Girls were more likely to be overweight or obese than boys in all the cohorts. Overweight and obesity were excluded from analysis in the NLSCY due to very high rates of missing height data. Missing data rates were low in all cohorts except ABIS.

Table 6-7: Summary of overweight/obesity, by group and cohort

	Group A		Group B			Group C	
	ECLS-K (US)	**MCS (UK)**	**LSAC-K (Australia)**	**NLSCY (Canada)**	**QLSCD (Canada)**	**Gen-R (Neth.)**	**ABIS (Sweden)**
% overweight/obese							
Total sample	18.3%	20.7%	20.5%	Excluded	Excluded	12.4%	16.9%
Girls	19.3%	23.0%	22.7%			15.0%	19.3%
Boys	17.4%	18.5%	18.4%			9.8%	14.8%
Number missing overweight data (%)	216 (2.3%)	178 (1.4%)	40 (0.9%)			8 (0.2%)	669 (9.3%)

Figure 6-6: Percentage of children who are overweight or obese, by group and cohort



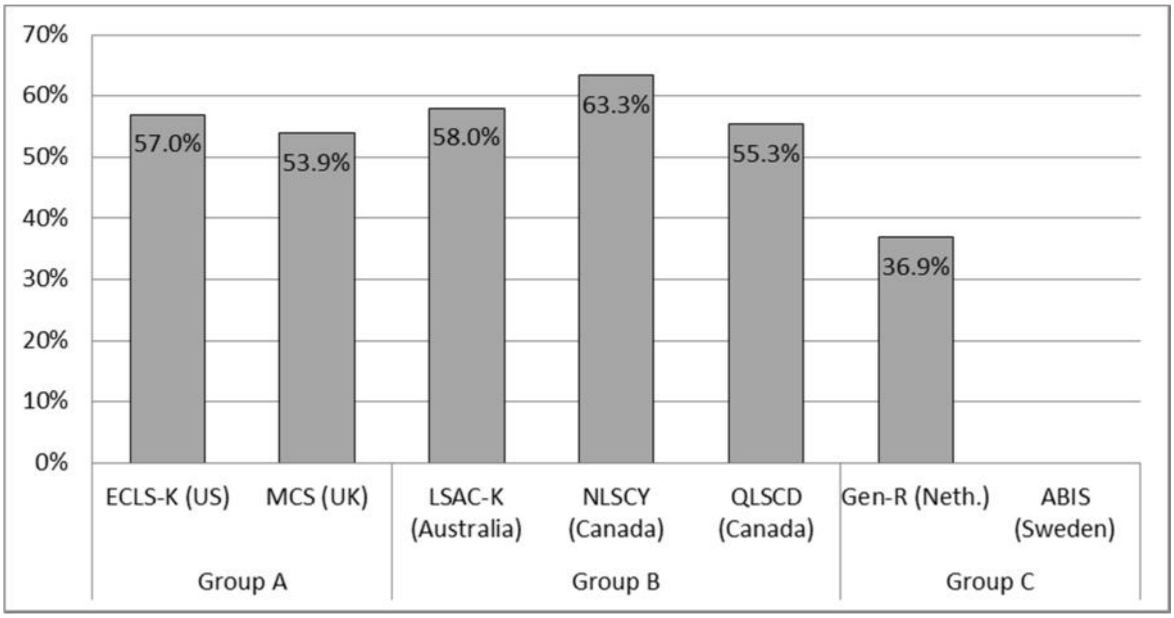
Excellent health

The proportion of children who were reported to be in excellent health by their parents ranged from 36.9% in Gen-R to 63.3% in the NLSCY (Table-6-8, Figure 6-6). The low rate in Gen-R was surprising, and possible reasons for this are discussed in chapter 8. There was a sex difference, with a higher proportion of girls with excellent health than boys in all cohorts except the QLSCD. Rates of missing data were low most cohorts, but very high in Gen-R.

Table 6-8: Summary of excellent health, by group and cohort

	Group A		Group B			Group C	
	ECLS-K (US)	**MCS (UK)**	**LSAC-K (Australia)**	**NLSCY (Canada)**	**QLSCD (Canada)**	**Gen-R (Neth.)**	**ABIS (Sweden)**
% with excellent health							
Total sample	57.0%	53.9%	58.0%	63.3%	55.3%	36.9%	Not available
Girls	58.1%	55.3%	59.8%	66.4%	54.8%	37.9%	
Boys	55.9%	52.5%	56.2%	60.4%	55.9%	36.0%	
Number missing general health data (%)	6 (0.1%)	43 (0.3%)	1 (0.0%)	33 (0.6%)	0	624 (17.1%)	

Figure 6-7: Percentage of children with excellent health, by group and cohort



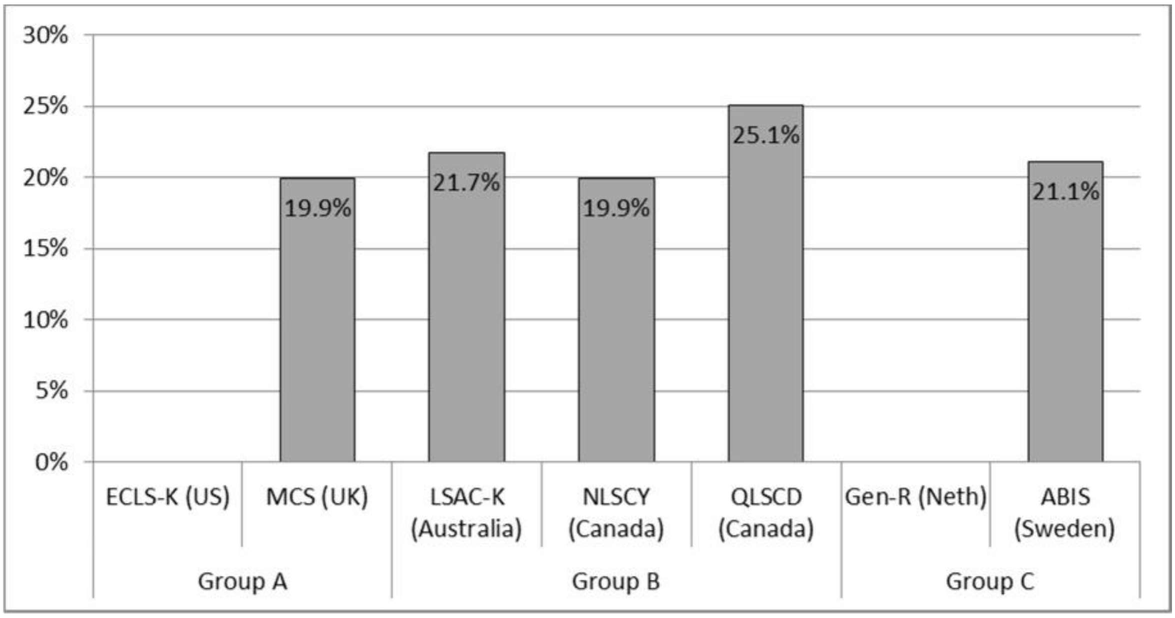
Chronic illness

Between 19.9% - 25.1% of children were reported by their parents to have a chronic illness (Table 6-9, Figure 6-8). The QLSCD contained the highest proportion of children reported to have chronic illnesses. There was a considerable gender difference, with higher proportions of boys reported to have chronic conditions in all cohorts. Data on chronic illness were not available in the ECLS-K. Rates of missing data were very low in all the cohorts.

Table 6-9: Summary of chronic illness, by group and cohort

	Group A		**Group B**			**Group C**	
	ECLS-K (US)	**MCS (UK)**	**LSAC-K (Australia)**	**NLSCY (Canada)**	**QLSCD (Canada)**	**Gen-R (Neth)**	**ABIS (Sweden)**
% with chronic illness							
Total sample	Not available	19.9%	21.7%	19.9%	25.1%	Not available	21.1%
Girls		17.5%	17.9%	17.5%	22.7%		17.9%
Boys		22.2%	25.3%	22.2%	27.5%		23.9%
Number missing chronic illness data (%)		49 (0.4%)	0	32 (0.6%)	0		0

Figure 6-8: Percentage of children who have chronic illnesses, by group and cohort



Emotional problems and anxiety

Emotional problems and anxiety scores were available in the MCS and LSAC-K (using the SDQ), the two Canadian cohorts (using locally-developed scales) and Gen-R (using the CBCL). The measurement differences between cohorts and standardisation procedure were outlined in chapter 5. Table 6-10 summarises the raw and standardised scores in each cohort. There was some variation in the raw emotional problem and anxiety scores, which are likely to reflect differences in measurement between the cohorts. The range of scores was similar across the

MCS, LSAC-K and Canadian cohorts (due to the same number of items and scoring), but wider in Gen-R (due to a larger number of items). The mean score was highest in the QLSCD.

Scores were standardised to mean=0, sd=1. The distribution of standardised scores is shown in Figure 6-9. The distribution is strongly right-skewed in the MCS, LSAC-K, NLSCY and Gen-R. However, the distribution is less right-skewed in the QLSCD (i.e. children were more likely to have parent reports of some emotional or anxiety symptoms).

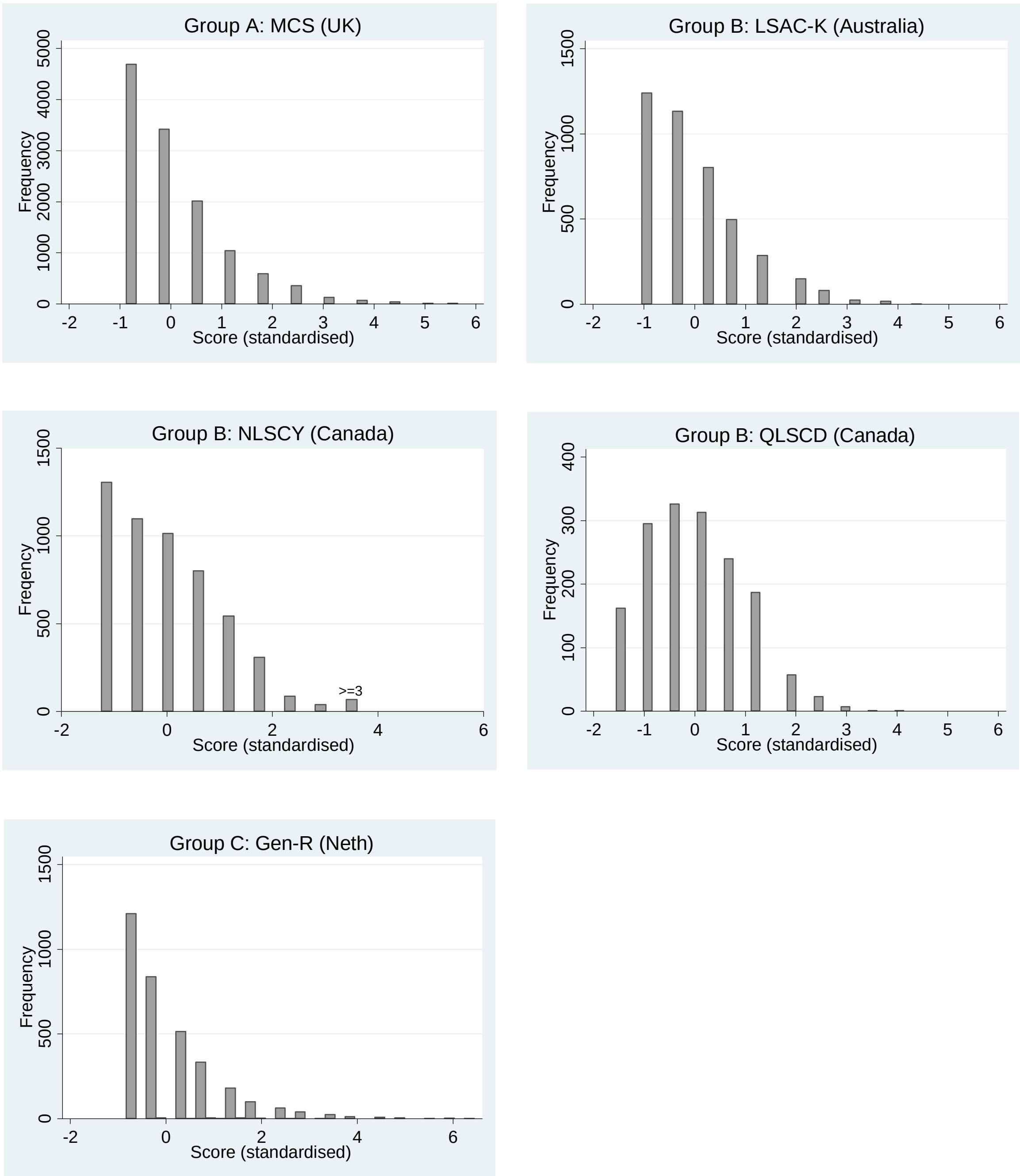
Rates of missing data for emotional problem/anxiety scores were very low in all cohorts, except Gen-R.

Table 6-10: Raw and standardised emotional problem/ anxiety scores, by group and cohort

	Group A		Group B			Group C	
	ECLS-K (US)	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Canada)	Gen-R (Neth)	ABIS (Swed)
Raw scores							
Total sample:							
mean	Not	1.3	1.7	2.0	2.7	1.6	Not
sd	Avail.	1.5	1.6	1.7	1.8	1.9	Avail.
median		1	1	2	3	1	
range		1: 10	0: 9	-	0: 10	0: 14	
Girls: mean		1.4	1.7	2.0	2.8	1.6	
sd		1.6	1.7	1.7	1.7	1.9	
median		1	1	2	3	1	
Boys: mean		1.4	1.7	2.0	2.7	1.6	
sd		1.6	1.6	1.7	1.8	2.0	
median		1	1	2	3	1	
Standardised scores							
Total sample:							
mean		0.00	0.00	0.0	0.00	0.00	
sd		1.00	1.00	1.0	1.00	1.00	
median		-0.21	-0.41	0.01	0.15	-0.31	
range		-0.86: 5.63	-1.02: 4.44	-	-1.55: 4.14	-0.83: 6.44	
Girls: mean		0.03	0.00	0.0	0.02	0.00	
sd		1.01	1.01	1.0	0.98	0.98	
median		-0.21	-0.41	0.01	0.15	-0.31	
Boys: mean		-0.03	0.00	0.0	-0.02	0.00	
sd		0.99	0.99	1.0	1.02	1.02	
median		-0.21	-0.41	0.01	0.15	-0.31	
Number missing emotion/anxiety data (%)		173 (1.4%)	7 (0.2%)	0	0	268 (7.4%)	

Note: ranges are not presented for the NLSCY, in compliance with Statistics Canada reporting rules

Figure 6-9: Distribution of emotional problem and anxiety scores (standardised) in the cohorts (unweighted)



Hyperactivity

Data on hyperactivity and inattention were available in the MCS and LSAC-K (using the SDQ), the two Canadian cohorts (using locally-developed scales) and Gen-R (using the CBCL). Summary statistics for raw and standardised scores are shown in Table 6-11. The range of raw scores was similar across cohorts (with a slightly larger range in Gen-R), but there were some differences in the mean scores. These differences may also reflect differences in measurement between cohorts.

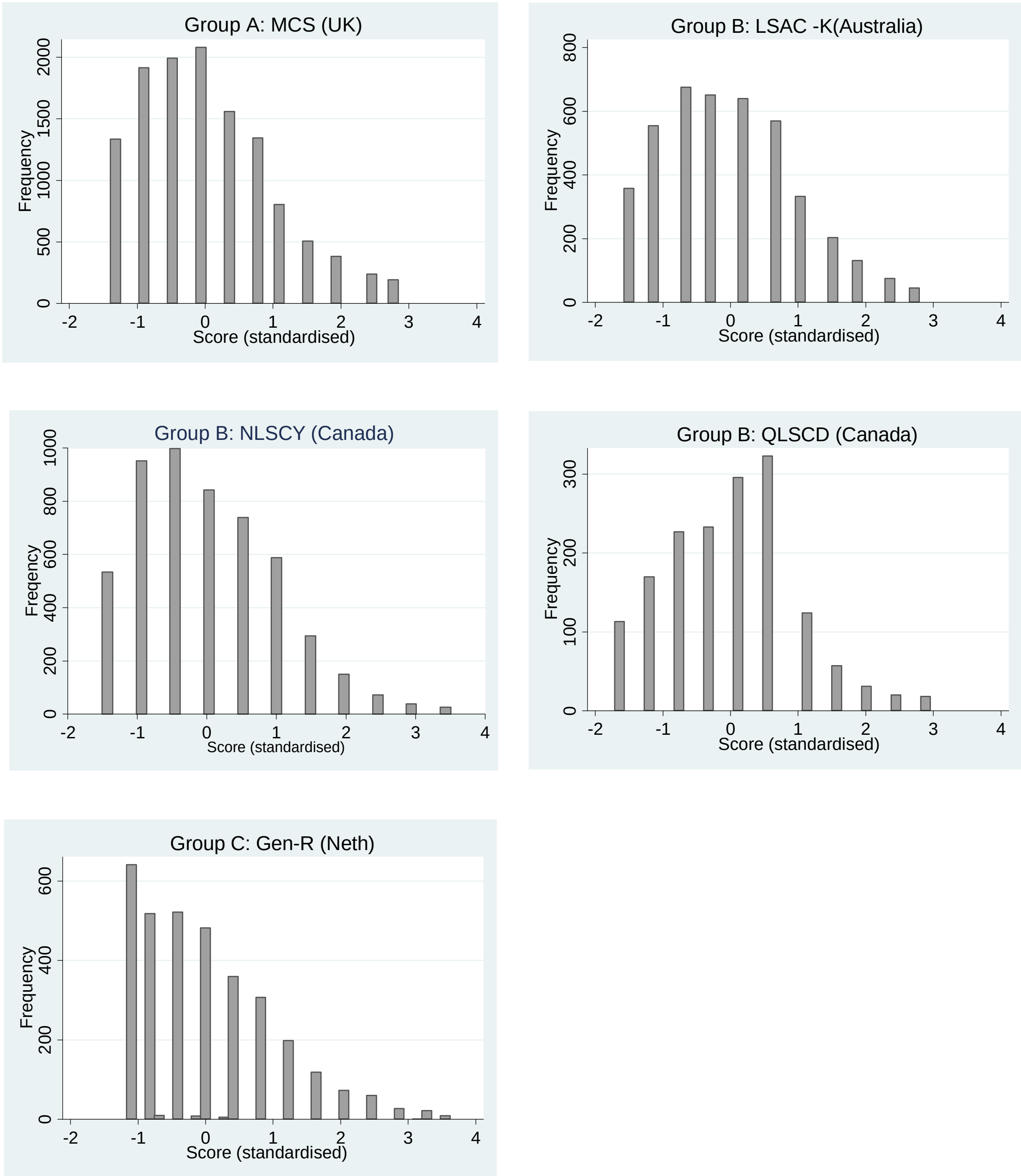
Hyperactivity scores were standardised to mean=0, sd=1. There were differences in standardised scores by sex. In all cohorts, boys had considerably higher standardised hyperactivity scores on average (i.e. higher levels of hyperactivity). The distribution of standardised scores is right-skewed the MCS, LSAC-K and NLSCY – and especially in Gen-R; as with emotional problems and anxiety score, the distribution is different in the QLSCD (Figure 6-10). Rates of missing hyperactivity and inattention data were low in all cohorts except Gen-R.

Table 6-11: Raw and standardised hyperactivity and inattention scores, by group and cohort

	Group A		Group B			Group C	
	ECLS-K (US)	**MCS (UK)**	**LSAC-K (Australia)**	**NLSCY (Canada)**	**QLSCD (Canada)**	**Gen-R (Neth.)**	**ABIS (Sweden)**
Raw scores							
Total sample: mean	Not	3.3	3.6	2.9	3.7	2.9	Not
sd	available	2.4	2.3	2.1	2.1	2.5	available
median		3	3	3	3		
range		0: 10	0: 10	-	0: 10	0: 12	
Girls: mean		2.9	3.2	2.6	3.4	2.6	
sd		2.3	2.2	1.9	2.0	2.3	
median		3	3	2	3		
Boys: mean		3.6	4.0	3.2	4.0	3.2	
sd		2.5	2.4	2.1	2.2	2.6	
median		3	4	3	3		
Sstandardised scores							
Total sample: mean		0.00	0.00	0.0	0.00	0.00	
sd		1.00	1.00	1.0	1.00	1.00	
median		-0.11	-0.26	0.00	0.16		
range		-1.37: 2.82	-1.56: 2.78	-	-1.71: 2.96	-1.16: 3.62	
Girls: mean		-0.15	-0.18	-0.1	-0.14	-0.11	
sd		0.95	0.94	0.9	0.94	0.93	
median		-0.11	-0.26	-0.14	-0.31		
Boys: mean		0.14	0.17	0.1	0.14	0.11	
sd		1.03	1.02	1.0	1.04	1.05	
median		-0.11	0.17	0.43	0.16		
Number missing hyperactivity/inattention data (%)		150 (1.2%)	6 (0.1%)	32 (0.6%)	0	270 (7.4%)	

Note: ranges are not presented for the NLSCY, in compliance with Statistics Canada reporting rules

Figure 6-10: Distribution of hyperactivity scores (standardised) in the samples (unweighted)



Verbal cognition

Verbal cognition scores were measured in the MCS, LSAC-K and NLSCY. Raw and standardised scores are presented in Table 6-12. Raw scores are difficult to compare due to differences in measurement between the cohorts (the LSAC –K and NLSCY used different versions of the PPVT and the MCS used the BAS.

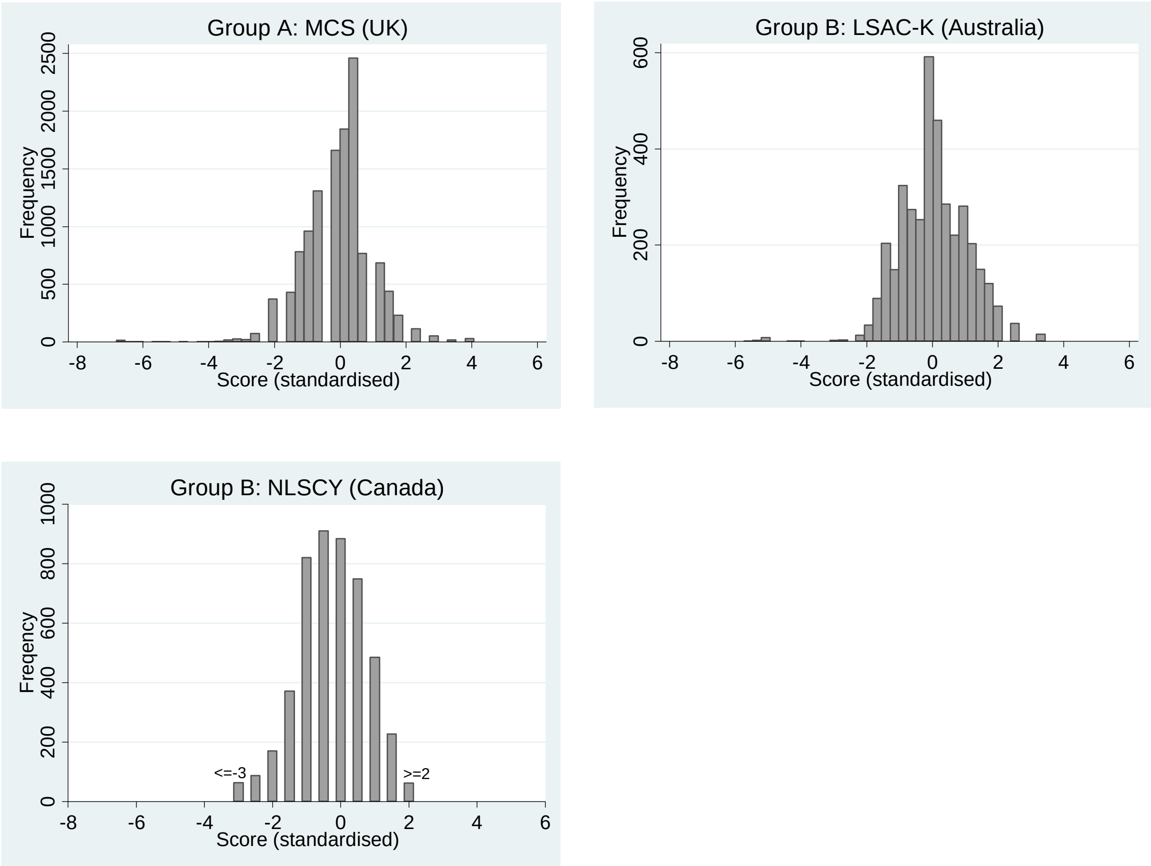
Scores were standardised to mean=0, sd=1. After standardisation, the range of scores was similar between cohorts. The distributions were relatively normal (with some deviations from the normal distribution, especially in the MCS sample) (Figure 6-11). Rates of missing data were higher for the verbal cognition scores than any other health/development outcome. The level of missing data was highest in the LSAC-K (10.6%) and NLSCY (8.3%).

Table 6-12: Raw and standardised verbal cognition scores, by group and cohort

	Group A		Group B			Group C	
	ECLS-K (US)	**MCS (UK)**	**LSAC-K (Australia)**	**NLSCY (Canada)**	**QLSCD (Can.)**	**Gen-R (Neth)**	**ABIS (Swed)**
Verbal cognition (raw scores)							
Total sample: mean	Not	110.1	64.5	60.3	Not	Not	Not
sd	Avail.	14.7	5.9	18.0	Avail.	Avail.	Avail.
range		10.0: 170.0	30.6: 84.8	-			
Girls: mean		110.6	64.9	62.0			
sd		14.0	5.9	17.3			
Boys: mean		109.6	64.1	58.8			
sd		15.3	5.9	18.4			
Verbal cognition (standardised)							
Total sample: mean		0.00	0.00	0.0			
sd		1.00	1.00	1.0			
range		-6.81: 4.08	-5.73: 4.43				
Girls: mean		0.03	0.07	0.0			
sd		0.95	1.01	1.0			
Boys: mean		-0.03	-0.07	-0.1			
sd		1.04	0.99	1.0			
Number missing verbal cognition data (%)		191 (1.5%)	448 (10.6%)	435 (8.3%)			

Note: ranges are not presented for the NLSCY, in compliance with Statistics Canada reporting rules

Figure 6-11: Distribution of verbal cognition scores (standardised) in the cohorts



6.6. Missing data

Rates of missing data were presented in tables summarising descriptive statistics for each variable in this chapter. Rates were low or very low for most cohorts and outcomes; data on verbal cognition was more likely to be missing. Rates of missing data were often particularly high in Gen-R.

Children with missing health/development outcome data were likely to come from households with low socioeconomic position (parents with low education or low household incomes). An analysis of the socioeconomic position of children with missing data is included in Appendix 6. Household incomes were lower, on average, for children with missing health/development outcome data, in comparison with mean incomes for the whole sample. The implications of these differences for interpretation of findings are considered in chapter 8.

6.7. Summary of chapter 6

1) The sizes of samples included in the analysis ranged from 1,612 in the QLSCD to 12,523 in the MCS. A particularly large proportion of the sample was excluded in the ECLS-K and Gen-R samples, due to large numbers of children from ethnic minority groups and children without socioeconomic data being excluded.
2) Children's ages averaged 4 ¾ to just over 6 years; children were oldest in Gen-R. The ratio of girls to boys was relatively similar across the cohorts.
3) Indicators of socioeconomic position varied considerably. Parental education levels were highest in the Group C cohorts (with very few in the lowest education category). Household income was very high in the ECLS, and low in Gen-R. These variations reflect measurement differences, as well as actual differences between the countries.
4) There was some variation in the levels of physical health between the cohorts.
    - Children were shortest in the LSAC-K and tallest in Gen-R. These differences are likely to reflect age differences between the samples.
    - Prevalence of overweight/obesity was highest among children in the MCS and LSAC-K (just over 20%), and lowest in Gen-R (just over 12%).
    - The proportion of children who were reported to be in excellent health by their parents ranged from 36.9% in Gen-R to 63.3% in the NLSCY.
    - Between 20% (MCS and NLSCY) and 25% (QLSCD) of children were reported by their parents to have a chronic illness.
5) Emotional problem/anxiety scores, hyperactivity/inattention scores and verbal cognition scores were standardised for comparison between cohorts. However, there remained differences in the distribution of standardised scores. It is not possible to compare the levels of standardised scores.
6) The rates of missing data were generally very low. There were some exceptions: Gen-R had a lot of missing data and data on verbal cognition were more likely to be missing

Chapter 7: Comparative cohort analysis - Social gradients in child health and development in relation to income inequality

This chapter presents and compares social gradients in child health and development in countries with different levels of income inequality. Social gradients are presented in physical health/development, behaviour/emotional development and cognitive development, in relation to both parental education and household income. Datasets from different countries are grouped into three categories of income inequality: Group A (high inequality), Group B (medium inequality) and Group C (low inequality).

7.1. Introduction

For each child health/development outcome, I have analysed gradients by a) parental education and b) household income (equivalised). Within each of these, I first present unadjusted gradients by parental education category or household income category (quintiles), using bar charts. I then present regression analyses, adjusting for differences in age and sex. I have also used the regression models to predict the expected outcome at different levels of parental education or household income. I have presented these gradients using point and line graphs. These allow comparison of child health and development between the cohorts, with age and gender held constant, at the same levels of socioeconomic position. The rationale for the choice of these socioeconomic position and outcome variables, and for the analysis methods, was presented in chapter 5.

All analyses of the MCS, ECLS-K, LSAC-K, NLSCY and QLSCD are weighted. Analyses of Gen-R and ABIS are not weighted, as weighting variables were not available. Full tables of findings, including both unweighted and weighted figures, are provided in Appendix 7. All regression findings (coefficients, Odds Ratios, standard errors and p-values) are presented to 2 decimal places. In accordance with Statistics Canada regulations, findings from the NLSCY have been rounded to 1 decimal place.

The three groups of countries with different levels of income inequality are colour coded in all graphs to facilitate comparisons. Throughout this chapter, all Group A (high inequality) findings are presented in dark blue, Group B (medium inequality) are in mid-blue and Group C (low inequality) are in light blue. A key to the colours and symbols used in all graphs in this chapter is provided in Figure 7-1.

Figure 7-1: Key to graphs in this chapter

Colour coding for income inequality groups in all graphs:

Group A cohorts (high income inequality)

Group B cohorts (medium income inequality)

Group C cohorts (low income inequality)

Graphs of unadjusted gradients:

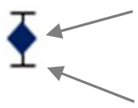
Parental education groups:

1	Bottom education category
2	2nd Education category
3	3rd Education category
4	4th Education category

Equivalised household income quintiles:

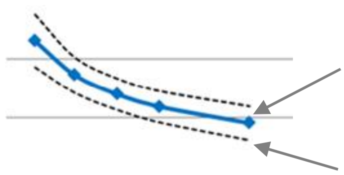
1	1st quintile (bottom)
2	2nd quintile
3	3rd quintile
4	4th quintile
5	5th quintile (top)

Graphs of predicted gradients using regression models:



Predicted outcome at parental education level (for child aged exactly 60 months)

95% confidence intervals



Predicted outcome at different points on the household income distribution (p5, p25, p50, p75, p95), for a child aged exactly 60 months in a 2 parent, 2 child household

95% confidence intervals

In each comparison of a health/development outcome by parental socioeconomic position, units of measurement and scales on the x and y axes are the same as far as possible in order to facilitate comparisons. One exception to this is the household income gradients in the ECLS-K cohort, which have a different income scale on the y axis from other graphs, due to the wide range in household income values in this cohort.

In order to highlight the slope of the gradient, I have added a dashed line from the marker to the y axis for the top and bottom marker in all graphs of predicted outcomes. I have included these lines only for girls if the relationship between SEP and the outcome is the same for girls and boys; where interactions between sex and SEP were significant I have also included lines for boys.

7.2. Physical health and development

Height

a) by parental education

Preliminary analysis of the height data showed a marked gradient in child height among girls and boys in Group A and Group B cohorts; gradients were less evident in the Group C cohorts. Children in the Gen-R cohort were tallest, and children in the LSAC cohort were shortest at all parental education levels. This difference reflects the differences in age of children in these samples (preliminary bivariate analyses did not control for child age).

Height was regressed on parental education, age and sex of children. This enabled us to take account of differences in child age between the samples. The estimates from linear regression models are shown in Table 7-1. Models were used to predict the mean heights for boys and girls aged at exactly 5 years with parents in each education category (Figure 7-3). These predicted values show how tall we expect a 5 year-old girl or boy to be in each of the datasets at each parental education level.

Parental education was overall a significant predictor of child height in all cohorts. The gradient in child height by parental education was steeper in the two Group A cohorts (MCS and ECLS-K) than in the group B cohort (LSAC-K). Although parental education was a significant predictor in the Group B and C cohorts, the gradient was shallower. In ABIS, it is important to note that the gradient was quite flat except for the lowest education category, which contained only 2% of children. There was no difference in gradients by sex (interaction between sex and parental education was not significant in any cohorts). Differences in level are also evident, after taking account of age: children were tallest in ABIS and Gen-R and shortest in the MCS and ECLS-K. In this analysis, we can see a ‘fanning out’ effect: children were taller in the most equal countries (after adjusting for age), at every parental education level. The difference was greatest among children with the least educated parents. In all the cohorts, boys were taller than girls.

The confidence intervals for predicted gradients in Gen-R are very wide in this analysis and later analyses. This is partly due to the age of children in the sample – predictions were made at the edge of the age distribution, reducing certainty. This is discussed further in chapter 8.

Figure 7-2: Mean height by parental education (unadjusted)

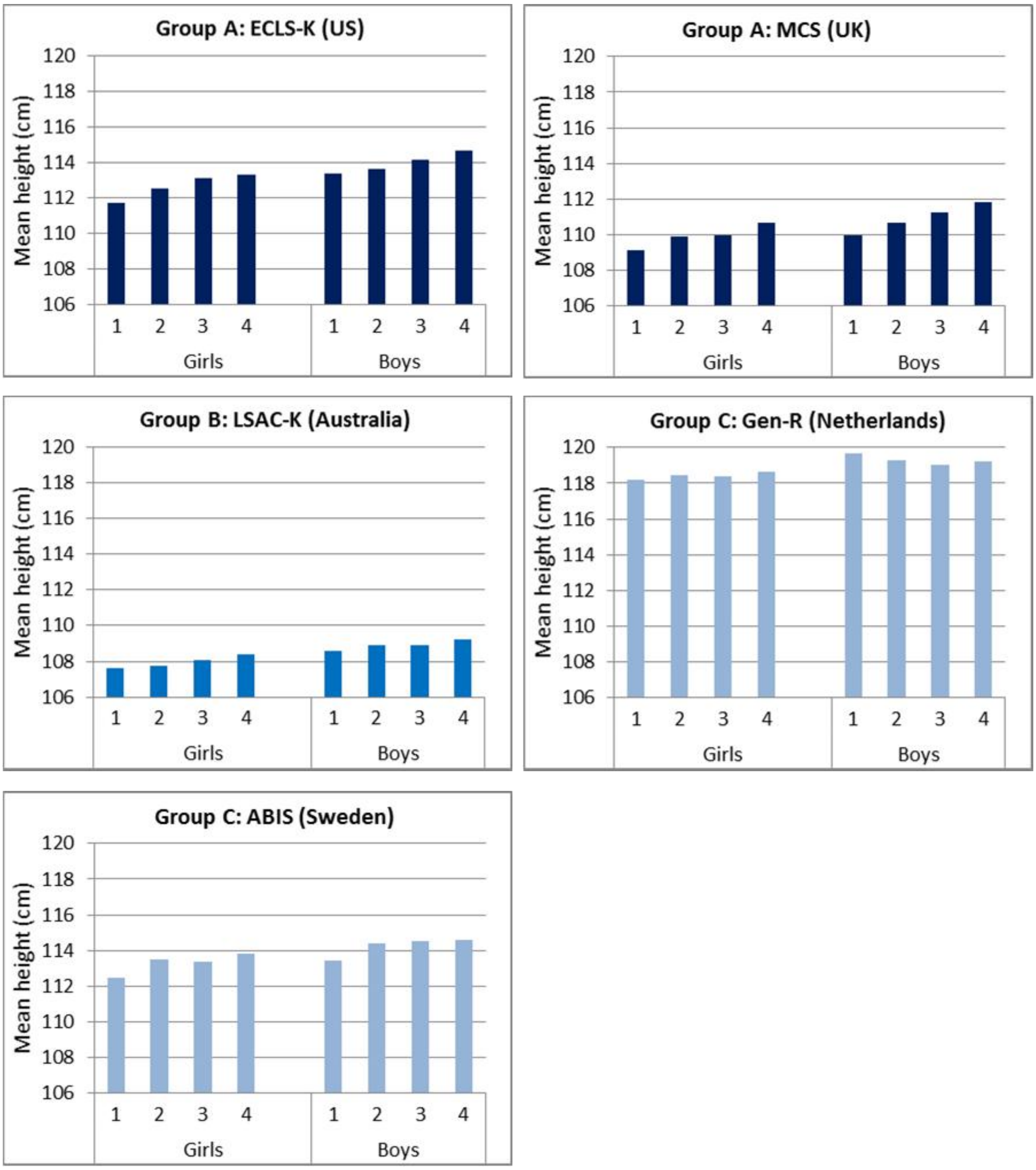
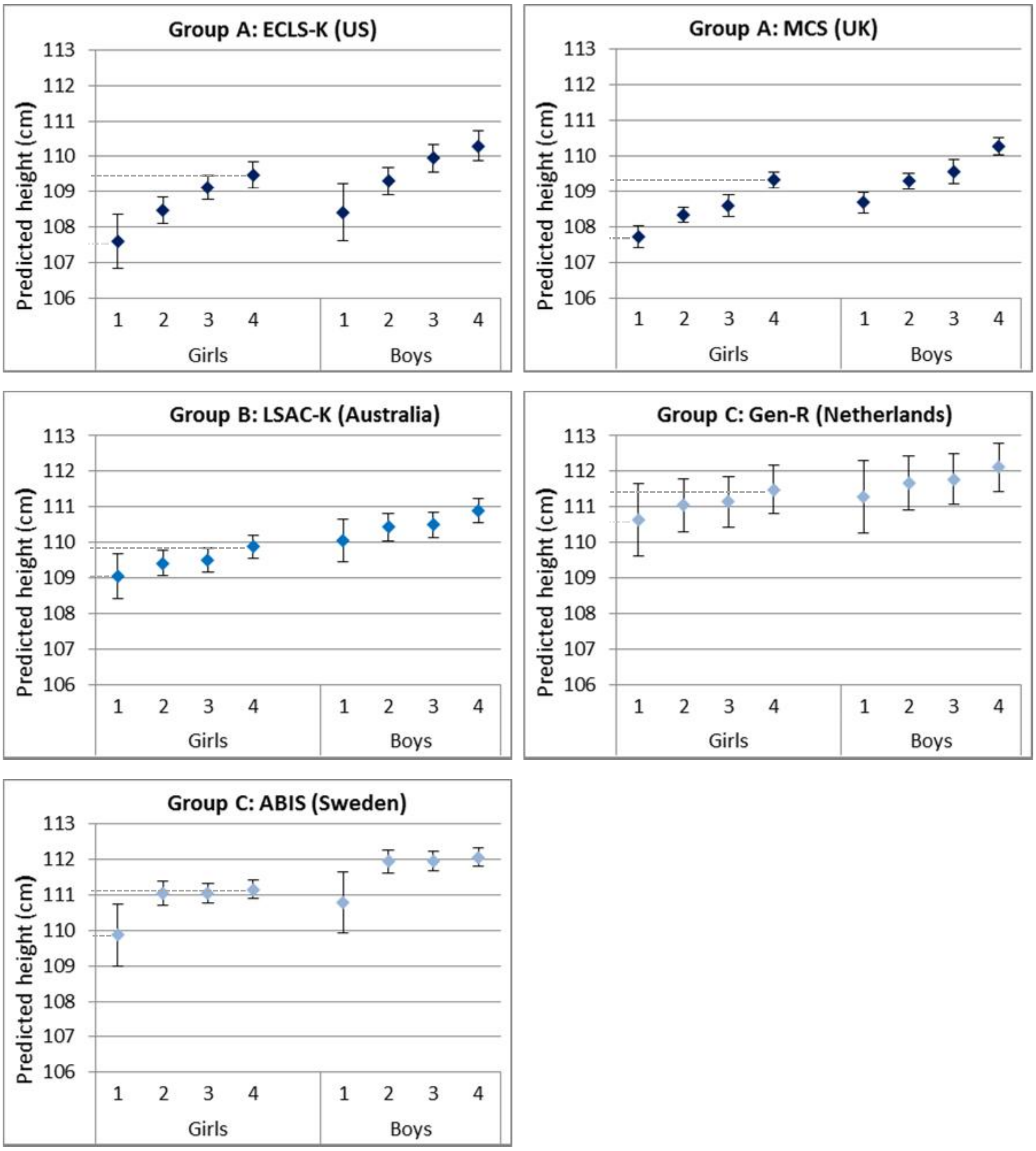


Table 7-1: Linear regression models for child height and parental education categories

	Group A						Group B		
	ECLS-K (US)			**MCS (UK)**			**LSAC-K (Australia)**		
	coef.	SE	p	coef.	SE	p	coef.	SE	p
Parental education									
Category 1	**-1.88**	**0.34**	**0.00**	**-1.60**	**0.16**	**0.00**	**-0.84**	**0.30**	**0.01**
Category 2	**-1.00**	**0.13**	**0.00**	**-0.99**	**0.13**	**0.00**	**-0.46**	**0.18**	**0.01**
Category 3	**-0.34**	**0.14**	**0.01**	**-0.72**	**0.18**	**0.00**	**-0.39**	**0.16**	**0.02**
Category 4 (baseline)	0.00			0.00			0.00		
Difference between parental education categories			**0.00**			**0.00**			**0.00**
Age (months)	**0.47**	**0.01**	**0.00**	**0.55**	**0.02**	**0.00**	**0.52**	**0.03**	**0.00**
Sex - boy	**0.83**	**0.12**	**0.00**	**0.96**	**0.11**	**0.00**	**1.01**	**0.15**	**0.00**
No. observations	9,282			12,182			4,191		
R2	0.15			0.13			0.10		

	Group C					
	Gen-R (Neth.)			**ABIS (Sweden)**		
	coef.	se	p	coef.	se	p
Parental education						
Category 1	**-0.85**	**-2.14**	**0.03**	**-1.28**	**0.44**	**0.00**
Category 2	**-0.44**	**-2.06**	**0.04**	-0.12	0.16	0.48
Category 3	-0.34	-1.71	0.09	-0.11	0.14	0.44
Category 4 (baseline)	0.00			0.00		
Difference between parental education categories			**0.04**			**0.03**
Age (months)	0.58	22.79	0.00	**0.56**	**0.02**	**0.00**
Sex - boy	0.63	3.81	0.00	**0.90**	**0.12**	**0.00**
No. observations	3,512			6,464		
R2	0.13			0.15		

Figure 7-3: Predicted height for children aged exactly 5 years at different parental education levels



b) by household income

Preliminary analysis of child height by household equivalised income quintile suggested a gradient in the Group A and B cohorts, most markedly in the MCS, but a less marked gradient in the Group C cohort (Figure 7-4). There were considerable variations in the level, although this largely reflects differences in the age of children in the samples.

Height was regressed on equivalised household income (continuous), adjusting for age and sex of children. The estimates from linear regression models are shown in Table 7-2. Equivalised household income was a very significant predictor of child height in all cohorts. The models were used to predict height for children aged 5 in a 2 adult, 2 child household at different levels of household income (p5, p25, p50, p75, p95) (Figure 7-5). These graphs allow us to compare the expected height (from the regression model) for children in exactly the same circumstances in both cohorts. The gradient by household income was evident in all cohorts. After controlling for age and sex, children were tallest, overall, in Gen-R. It is difficult to compare the slope of the gradients due to differences in the length (i.e. range of income values). In these graphs, we can see that the gap between the height of children at the 5^{th} and 95^{th} percentiles is greatest in the Group A cohorts and smallest in the Group C cohort.

Figure 7-4: Mean height by equivalised household income quintile (unadjusted)

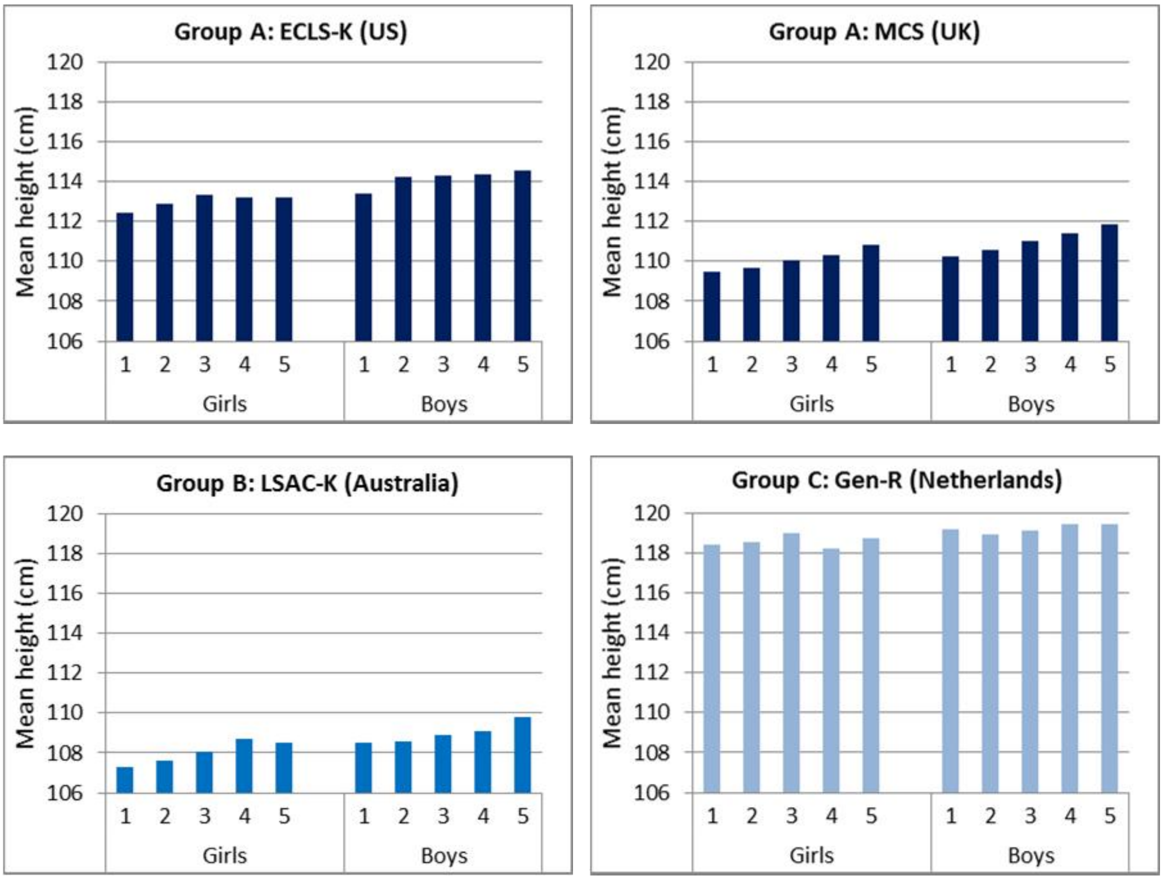
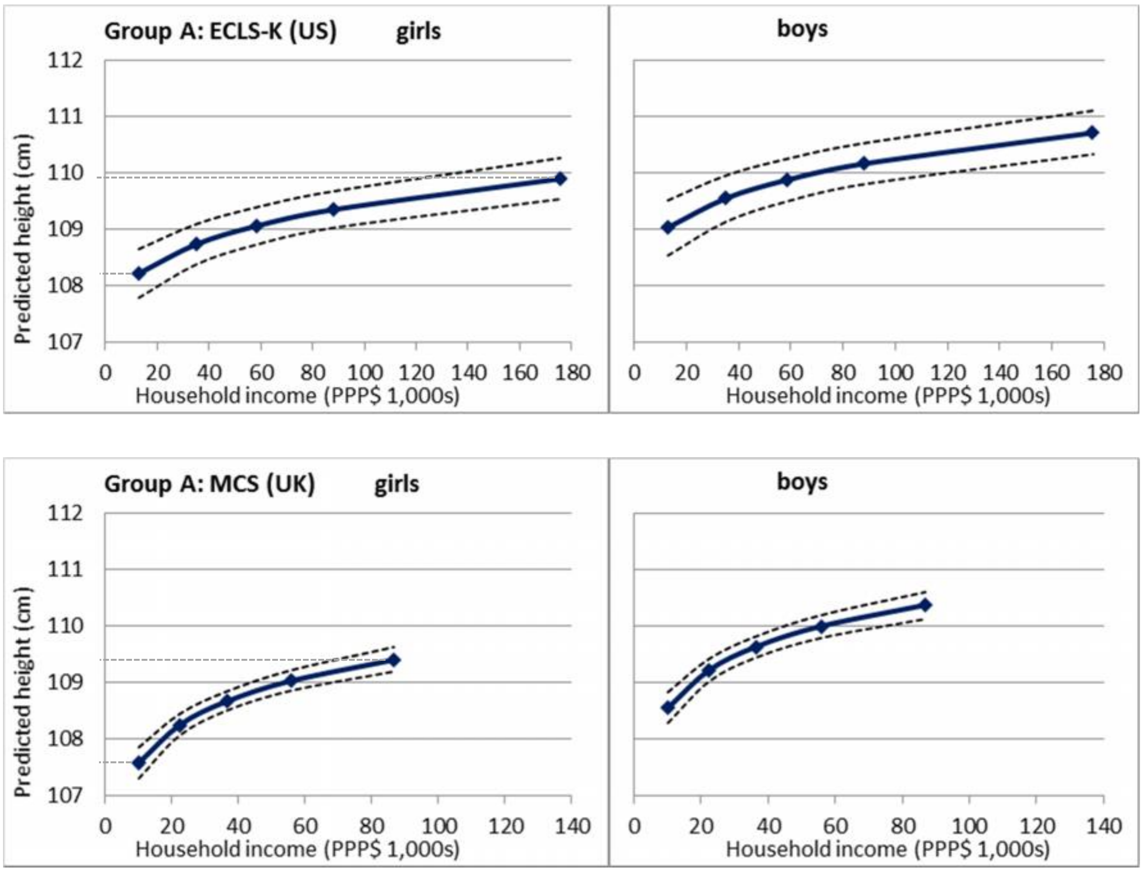


Table 7-2: Linear regression models for child height and continuous equivalised household income, age and sex

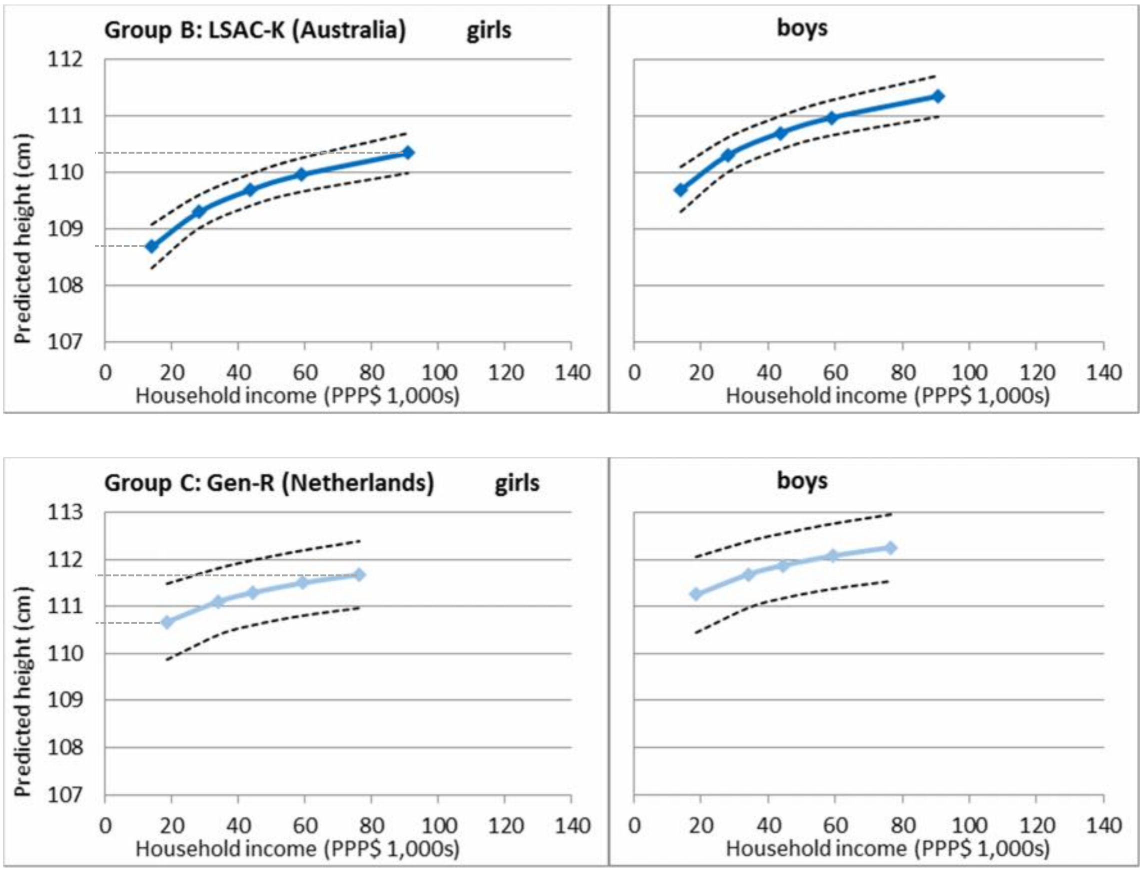
	Group A					
	ECLS-K (US)			MCS (UK)		
	coef.	SE	p	coef.	SE	p
Log equiv. household income (PPP$)	**-0.95**	**0.31**	**0.00**	**0.85**	**0.08**	**0.00**
Log equiv. household income (PPP$) ^2	**0.08**	**0.02**	**0.00**			
Age (months)	**0.47**	**0.01**	**0.00**	**0.55**	**0.02**	**0.00**
Sex - boy	**0.82**	**0.12**	**0.00**	**0.97**	**0.11**	**0.00**
No. observations	9,257			12,170		
R2	0.15			0.13		

	Group B			Group C		
	LSAC-K (Australia)			Gen-R (Neth.)		
	coef.	SE	p	coef.	se	p
Log equiv. household income (PPP$)	**0.89**	**0.13**	**0.00**	**0.71**	**0.21**	**0.00**
Log equiv. household income (PPP$) ^2						
Age (months)	**0.52**	**0.03**	**0.00**	**0.58**	**0.03**	**0.00**
Sex - boy	**1.02**	**0.15**	**0.00**	**0.58**	**0.17**	**0.00**
No. observations	4,073			3,311		
R2	0.10			0.13		

Figure 7-5: Predicted height for children aged exactly 5 years living in a 2 parent, 2 child household, at different levels of household income (p5, p25, p50, p75, p95)



(Figure 7-5 continued)



Overweight and obesity

a) by parental education

Preliminary analysis of overweight and obesity by parental education showed steep gradients in one Group A cohort (the MCS) and the Group C cohorts (Gen-R and ABIS). In the ECLS-K and the LSAC-K, gradients were clear among girls, but less evident among boys (Figure 7-6). The overall level of overweight/obesity is lowest in the Group C cohorts.

Regression analyses of overweight and obesity on parental education, age and sex are shown in Table 7-3. The Odds Ratios can be interpreted as the odds of being overweight or obese in each parental education category in relation to children in the highest parental education category (degree or higher). Parental education was overall a significant predictor of overweight/obesity in all the cohorts. Although bivariate analyses had suggested some differences by sex, interactions between parental education and child sex were not significant in any of the cohorts. The predicted probability of being overweight or obese by parental education category is presented in Figure 7-7. The gradient is steepest in the MCS (Group A), Gen-R and ABIS (both Group C). In the ECLS-K, there is a steep gradient among children with parents with secondary, post-secondary/technical and degree or higher education, however this pattern is not evident among children from the below secondary education category. However, the number of children in this category is small and the confidence intervals are wide. In all the cohorts the odds of being overweight or obese were significantly higher for girls.

Figure 7-6: The proportion of children who are overweight or obese by parental education (unadjusted)

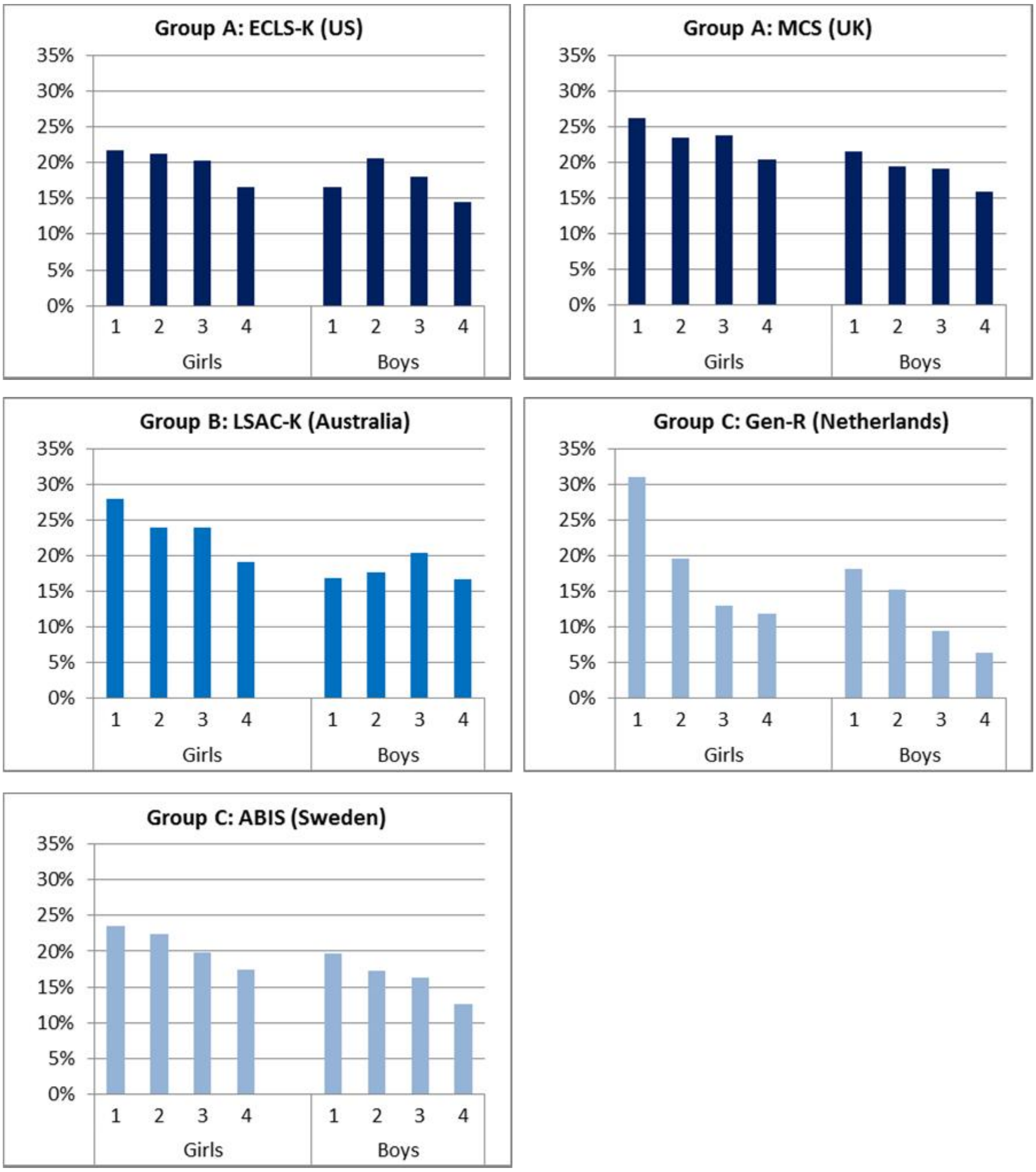
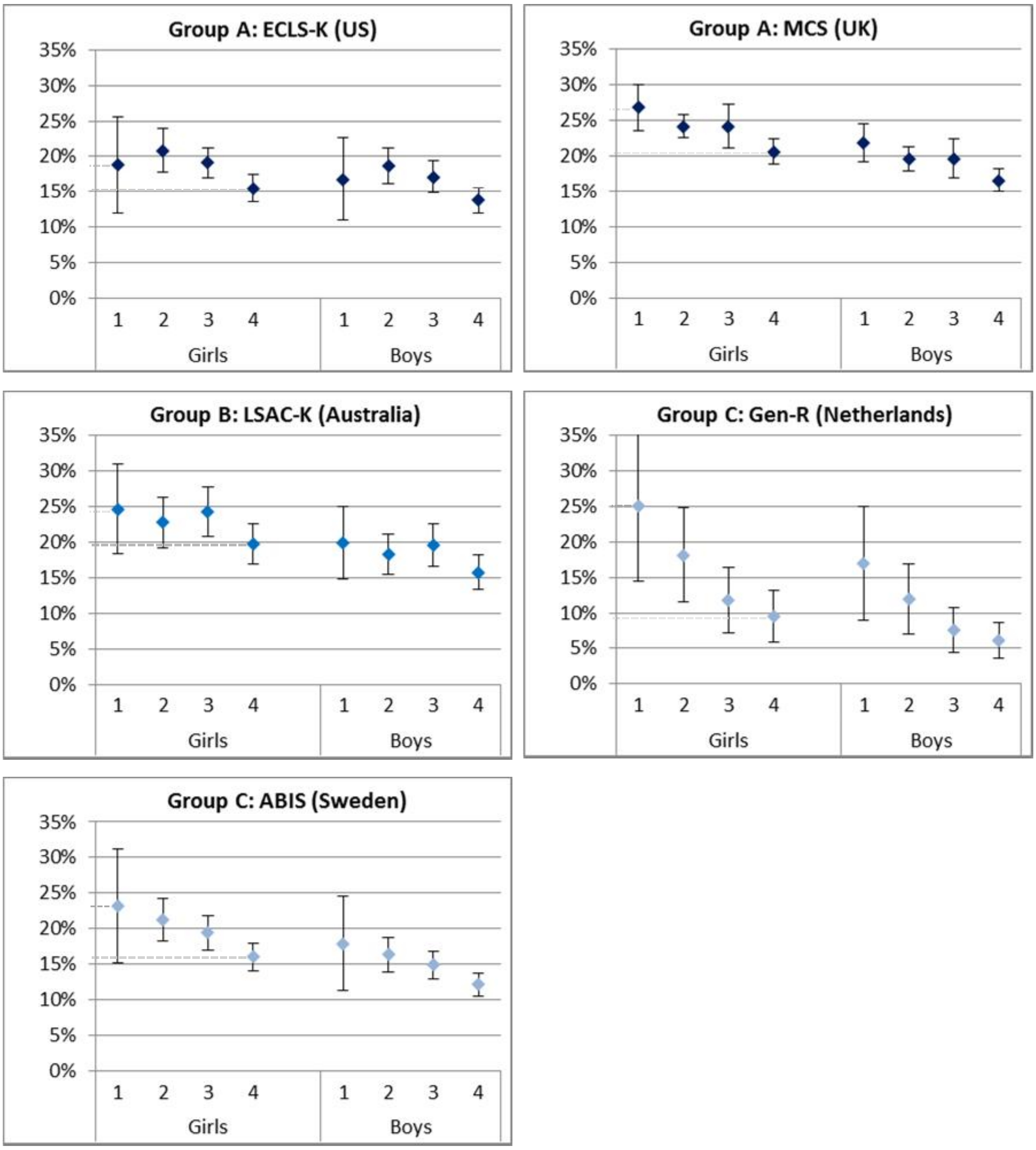


Table 7-3: Logistic regression models for overweight and obesity with parental education categories, age and sex

	Group A					
	ECLS-K (US)			MCS (UK)		
	OR	SE	p	OR	SE	p
Parental education						
Category 1	1.26	0.27	0.29	**1.41**	**0.13**	**0.00**
Category 2	**1.44**	**0.12**	**0.00**	**1.23**	**0.07**	**0.00**
Category 3	**1.29**	**0.09**	**0.00**	**1.23**	**0.12**	**0.03**
Category 4 (baseline)	1.00			1.00		
Difference between parental education categories			**0.00**			**0.00**
Age (months)	1.01	0.01	0.17	0.99	0.01	0.27
Sex - boy	**0.87**	**0.05**	**0.01**	**0.77**	**0.04**	**0.00**
No. observations	9,279			12,171		

	Group B			Group C					
	LSAC-K (Australia)			Gen-R (Neth.)			ABIS (Sweden)		
	OR	SE	p	coef.	se	p	coef.	se	p
Parental education									
Category 1	1.33	0.22	0.08	**3.16**	**0.64**	**0.00**	**1.58**	**0.36**	**0.05**
Category 2	1.20	0.12	0.06	**2.10**	**0.27**	**0.00**	**1.41**	**0.13**	**0.00**
Category 3	**1.30**	**0.12**	**0.01**	1.26	0.17	0.09	**1.26**	**0.10**	**0.00**
Category 4 (baseline)	1.00			1.00			1.00		
Difference between parental education categories			**0.00**			**0.00**			**0.00**
Age (months)	1.00	0.02	0.76	1.01	0.02	0.38	1.02	0.01	0.11
Sex - boy	**0.76**	**0.06**	**0.00**	**0.61**	**0.07**	**0.00**	**0.73**	**0.05**	**0.00**
No. observations	4,184			3,512			6,452		

Figure 7-7: Predicted probability of being overweight or obese for children aged exactly 5 years at different parental education levels



b) by household income

Preliminary analysis of overweight/obesity by equivalised household income quintile suggested that gradients were present in all cohorts (although there was some variation between quintiles) (Figure 7-8).

Overweight and obesity was regressed on continuous equivalised household income, age and sex. Equivalised household income was a significant predictor of overweight/obesity all the cohorts analysed. Predicted overweight/obesity levels at age 5 are shown in Figure 7-9. Gradients were evident in all cohorts, and were steepest in the MCS and Gen-R. The confidence intervals are wide for the LSAC-K and Gen-R predictions.

Figure 7-8: The proportion of children who are overweight or obese by equivalised household income quintile (unadjusted)

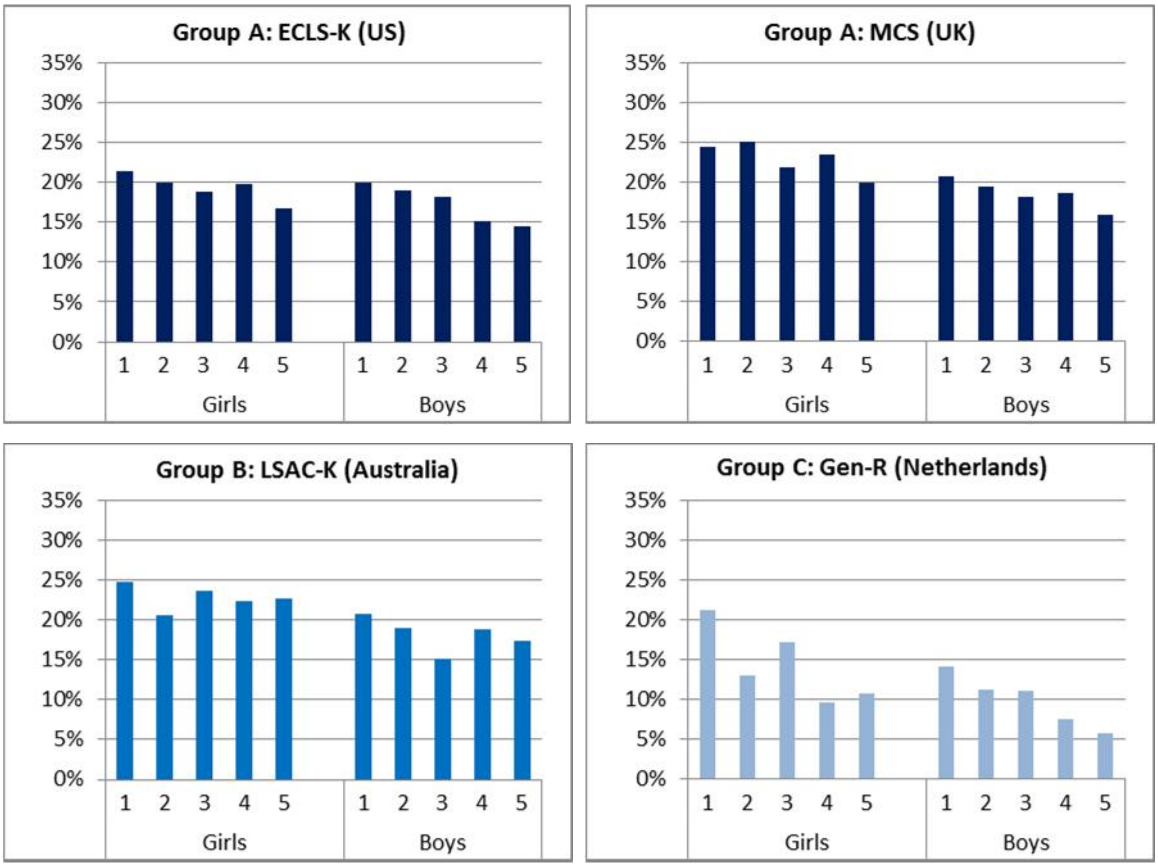
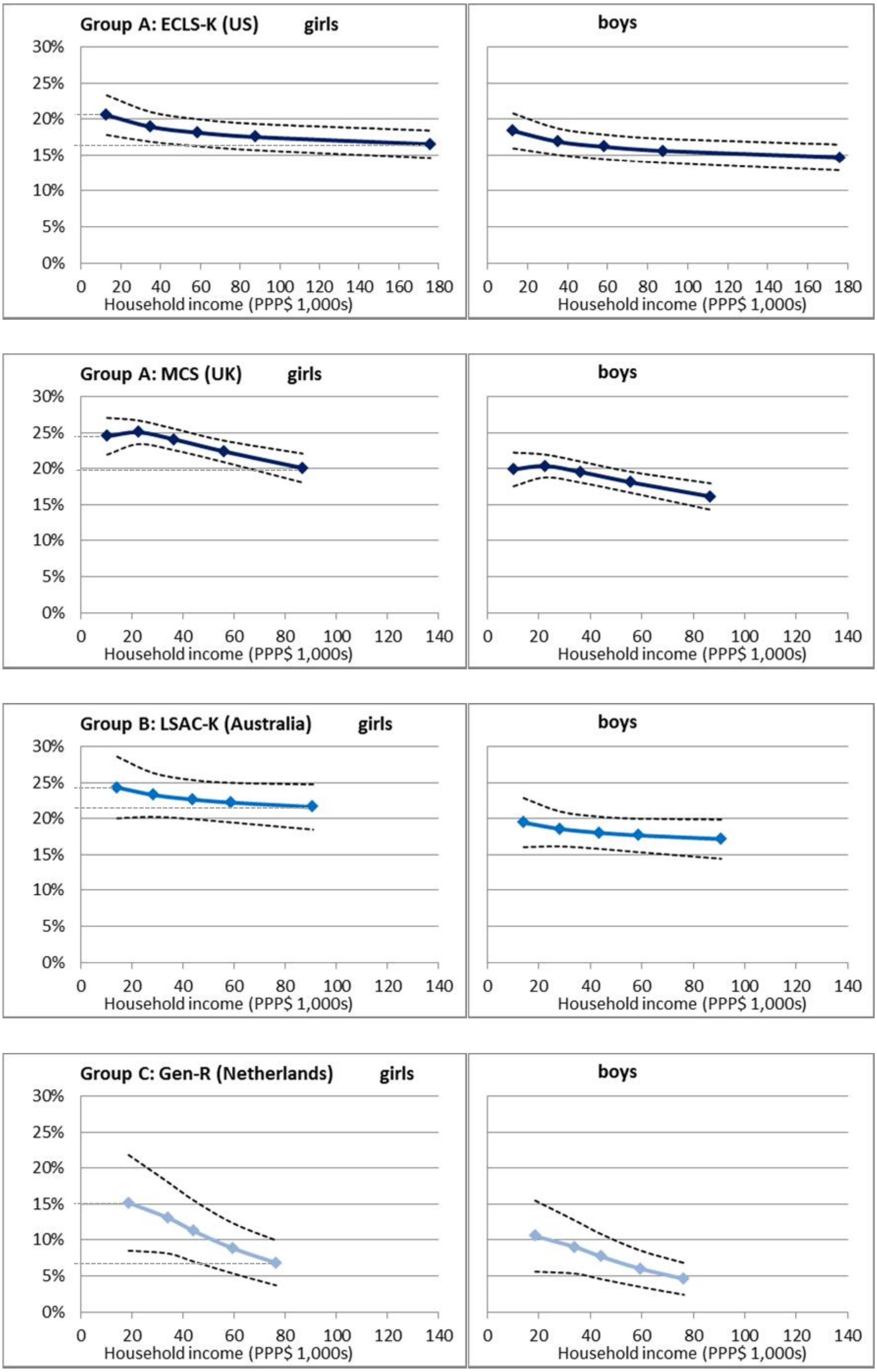


Table 7-4: Logistic regression models for overweight and obesity with continuous equivalised household income, age and sex

	Group A					
	ECLS-K (US)			MCS (UK)		
	OR	SE	p	OR	SE	p
Log equiv. household income (PPP$)	**0.90**	**0.03**	**0.00**	**8.09**	**6.63**	**0.01**
Log equiv. household income (PPP$) ^2				**0.89**	**0.04**	**0.01**
Age (months)	1.01	0.01	0.23	0.99	0.01	0.27
Sex - boy	**0.87**	**0.05**	**0.01**	**0.77**	**0.04**	**0.00**
No. observations	9,254			12,159		

	Group B			Group C		
	LSAC-K (Australia)			Gen-R (Neth.)		
	OR	SE	p	OR	se	p
Log equiv. household income (PPP$)	0.92	0.07	0.28	**2469**	**12213**	**0.11**
Log equiv. household income (PPP$) ^2				**0.65**	**0.16**	**0.09**
Age (months)	1.00	0.02	0.94	1.02	0.02	0.14
Sex - boy	**0.75**	**0.06**	**0.00**	**0.66**	**0.07**	**0.00**
No. observations	4,066			3,311		

Figure 7-9: Predicted probability of being overweight or obese for children aged exactly 5 years living in a 2 parent, 2 child household, at different levels of household income (p5, p25, p50, p75, p95)

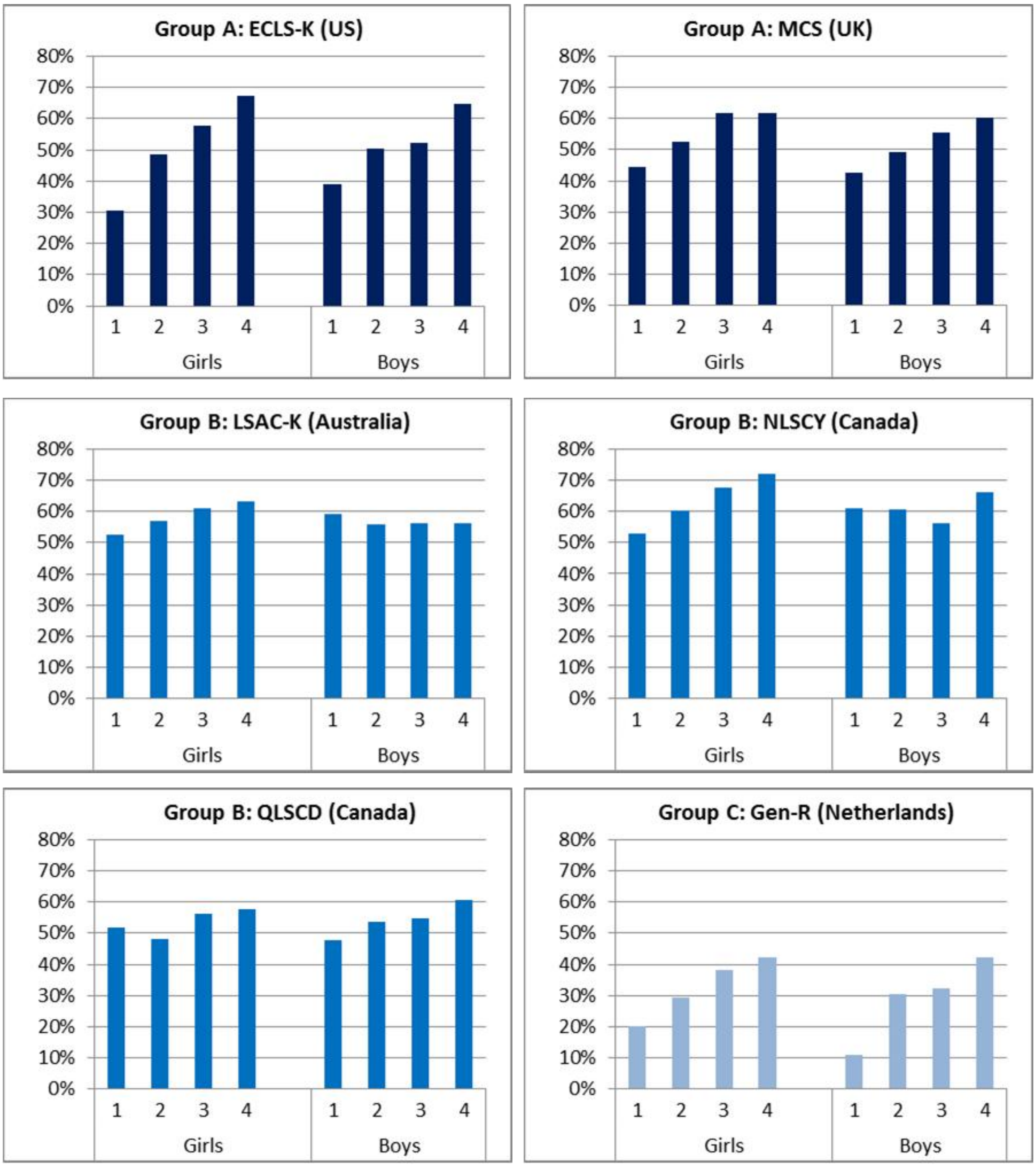


Excellent health

a) by parental education

Figure 7-10 shows unadjusted gradients in children's excellent health (as reported by parents) by parental education category. There was a marked gradient in excellent health among girls and boys in both Group A cohorts and in the Group C cohort. In the Group B cohorts, the picture is mixed. In the LSAC-K and NLSCY, there was a gradient among boys, however the gradient is not evident among girls; in the QLSCD there was no apparent gradient by parental education. There is considerable variation in the level of excellent health: parents were much less likely to report that their children were in excellent health in Gen-R.

Figure 7-10: The proportion of children with excellent health by parental education (unadjusted)



The logistic regression models presented in Table 7-5 regressed excellent health on parental education, child age and sex. Parental education was a significant predictor of excellent health in both of the Group A cohorts, the Group C cohort and one of the three Group B cohorts (NLSCY). Although some sex differences were evident in the unadjusted analysis, interactions between parental education and child sex were not significant in any cohorts. In some cohorts, girls had higher odds of being reported to be in excellent health than boys, but this pattern was not consistent across all cohorts.

The predicted probabilities of having excellent health for a child aged 5 years from these models are presented in Figure 7-11. These graphs show a marked and steep gradient by parental education in both Group A cohorts and the Group C cohort. In the Group B cohorts, predicted gradients were shallower and less significant, with wide confidence intervals.

The level of predicted excellent health varies between countries. The level of excellent health is lowest in the Group C cohort (Gen-R) – at all parental education levels. The picture in Group B is mixed, with the highest predicted proportions with excellent health in the LSAC-K and NLSCY (but lower in the QLSCD). In the Group A countries, although children whose parents have high levels of education had similar levels of excellent health to the LSAC-K and NLSCY, children with low-educated parents were much less likely to be in excellent health than children in similar circumstances in the LSAC-K and NLSCY.

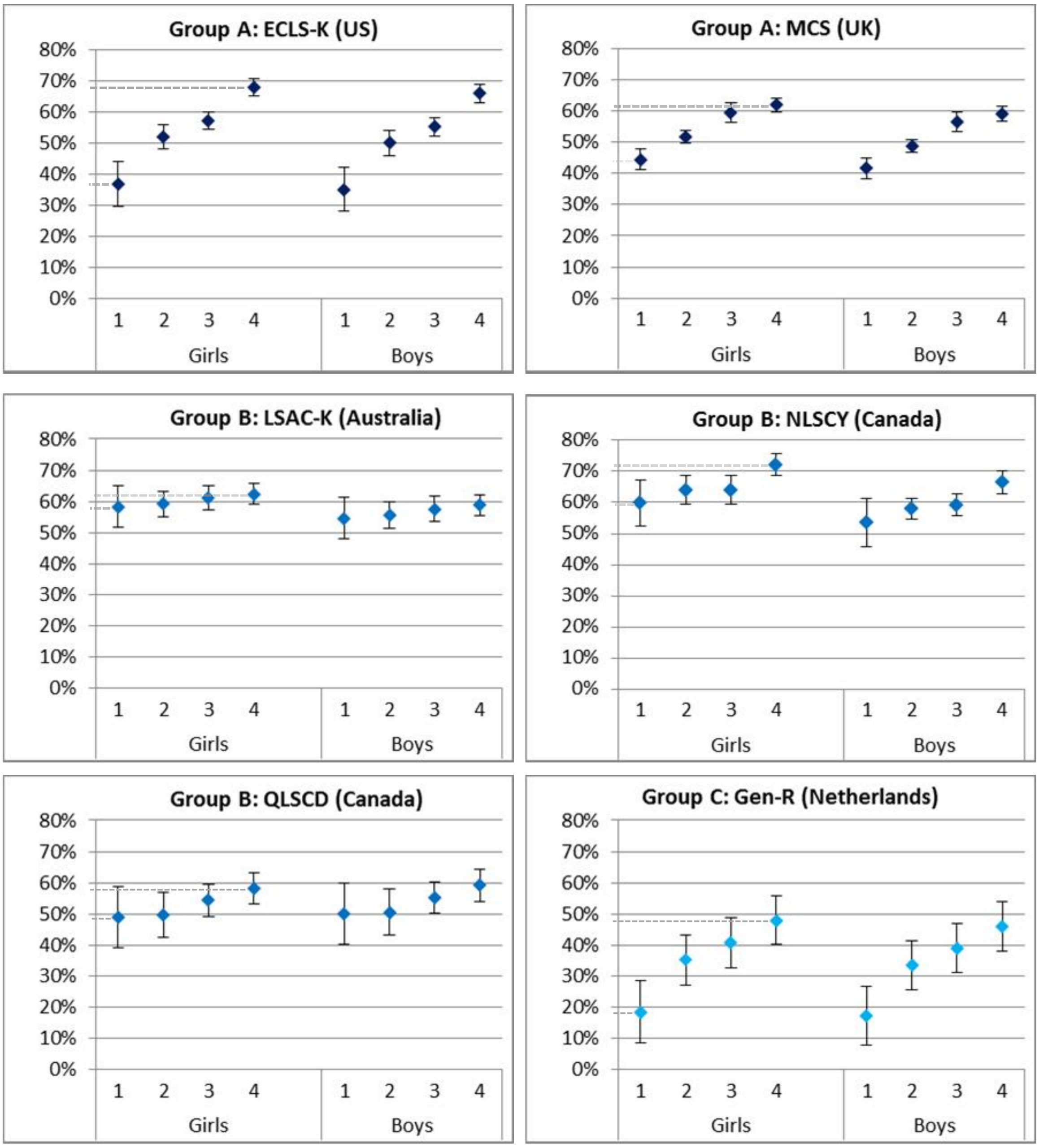
Table 7-5: Logistic regression models for excellent health and parental education categories, age and sex

	Group A						Group B		
	ECLS-K (US)			MCS (UK)			LSAC-K (Australia)		
	OR	SE	p	OR	SE	p	OR	SE	p
Parental education									
Category 1	**0.28**	**0.04**	**0.00**	**-1.60**	**0.16**	**0.00**	0.84	0.12	0.22
Category 2	**0.52**	**0.04**	**0.00**	**-0.99**	**0.13**	**0.00**	0.88	0.07	0.10
Category 3	**0.63**	**0.03**	**0.00**	**-0.72**	**0.18**	**0.00**	0.95	0.08	0.54
Category 4 (baseline)	1.00			1.00			1.00		
Difference between parental education categories			**0.00**			**0.00**			0.31
Age (months)	1.00	0.01	0.37	**0.55**	**0.02**	**0.00**	1.01	0.01	0.37
Sex - boy	0.92	0.04	0.06	**0.96**	**0.11**	**0.00**	**0.86**	**0.06**	**0.02**
No. observations	9,305			12,182			4,222		

	Group B						Group C		
	NLSCY (Canada)			QLSCD (Canada)			Gen-R (Neth.)		
	OR	SE	p	OR	SE	p	OR	SE	p
Parental education									
Category 1	**0.6**	**0.1**	**0.0**	0.69	0.14	0.08	**0.24**	**0.07**	**0.00**
Category 2	**0.7**	**0.1**	**0.0**	**0.71**	**0.11**	**0.03**	**0.59**	**0.06**	**0.00**
Category 3	**0.7**	**0.1**	**0.0**	0.86	0.11	0.20	**0.74**	**0.07**	**0.00**
Category 4 (baseline)	1.0			1.00					

Overal significance of parental education			**0.0**			0.09	**0.00**		
Age (months)	1.0	0.1	0.5	1.04	0.11	0.72	0.98	0.01	0.19
Sex - boy	**0.8**	**0.1**	**0.0**	1.01	0.02	0.51	0.93	0.07	0.33
No. observations	5,145			1,612			2,977		

Figure 7-11: Predicted probability of having excellent health for children aged exactly 5 years at different parental education levels



b) by household income

Figure 7-12 shows the proportion of children with excellent health, by equivalised household income quintile. As with parental education, there was a steep gradient in excellent health by household income in the Group A and Group C cohorts. Gradients were also evident in Group B cohorts, although there were some inconsistent patterns.

Figure 7-12: The proportion of children with excellent health by equivalised household income quintile (unadjusted)

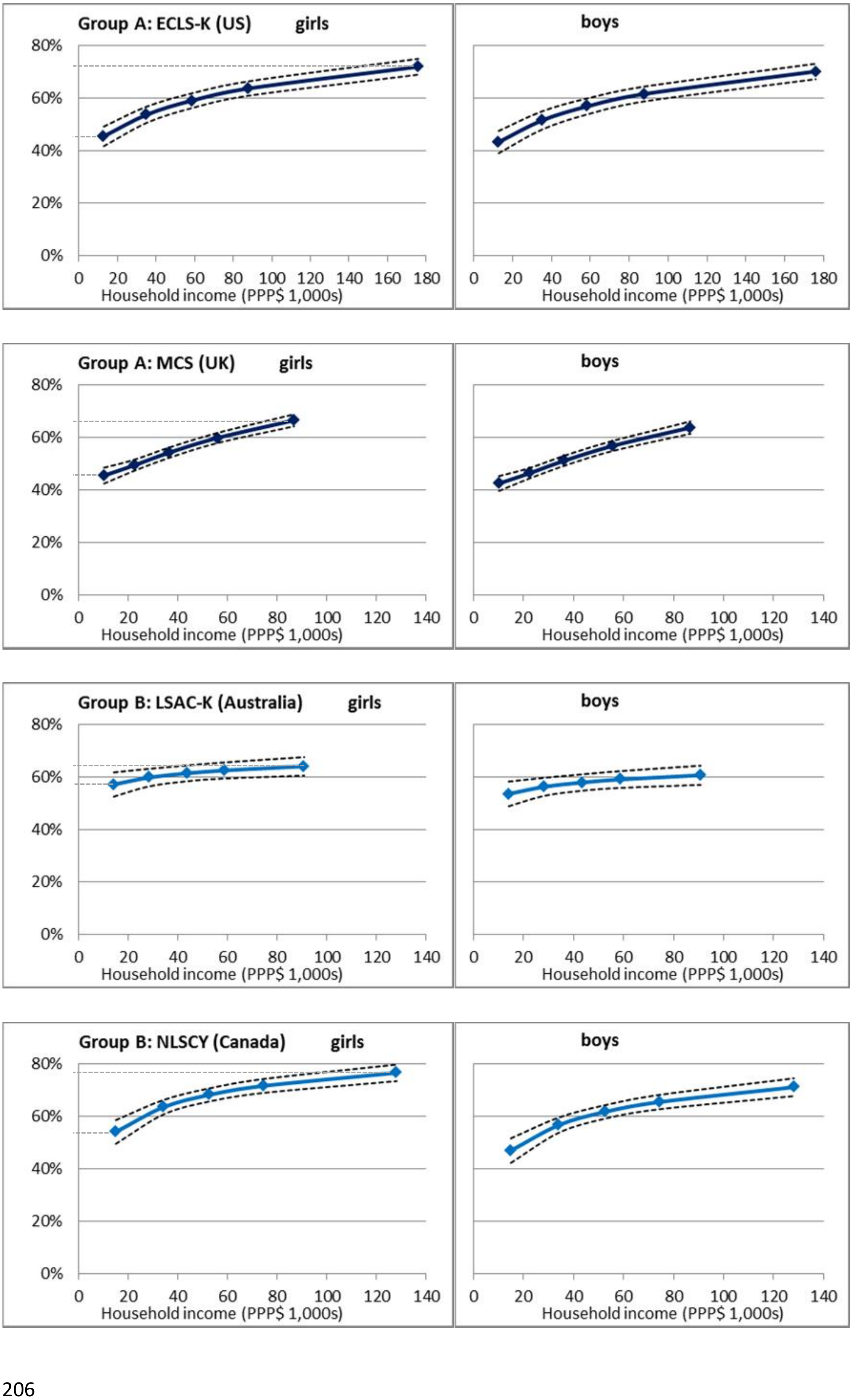
Logistic regression models regressed excellent health on continuous equivalised household income, child age and sex (Table 7-6). Equivalised household income was a significant predictor of excellent health in all the cohorts. These models were used to predict the probability of being in excellent health for children aged 5 in a 2 adult, 2 child household at different levels of household income (p5, p25, p50, p75, p95) (Figure 7-13). There were marked gradients in excellent health in the Group A and Group C cohorts. In the Group B cohorts, gradients were evident in the two cohorts from Canada, but shallower and with wide confidence intervals in the LSAC-K cohort. As observed in the gradients by parental education, the level of parent reported excellent health was lowest across all household incomes in Gen-R.

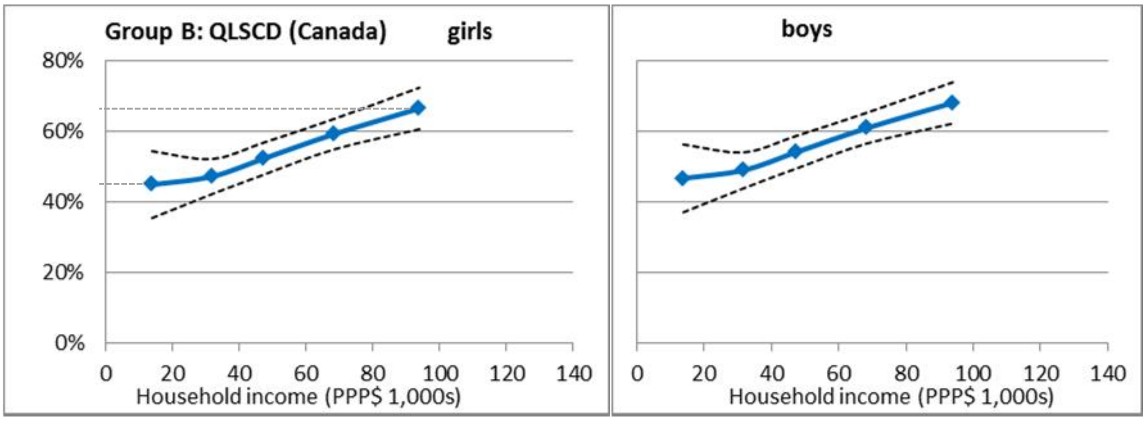
Table 7-6: Logistic regression models for excellent health and continuous equivalised household income, age and sex

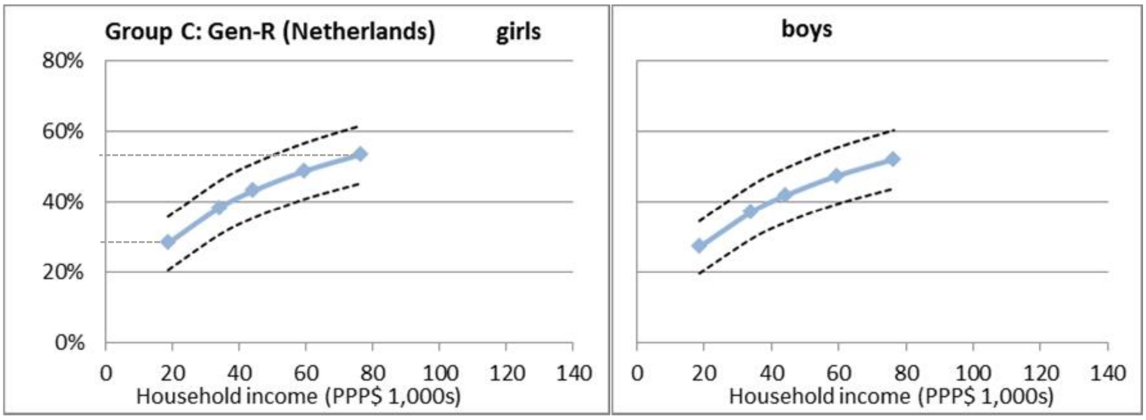
	Group A						**Group B**		
	ECLS-K (US)			**MCS (UK)**			**LSAC-K (Australia)**		
	OR	SE	p	OR	SE	p	OR	SE	p
Log equiv. household income (PPP$)	**0.43**	**0.08**	**0.00**	**0.08**	**0.05**	**0.00**	**1.17**	**0.07**	**0.01**
Log equiv. household income (PPP$) ^2	**1.06**	**0.01**	**0.00**	**1.16**	**0.04**	**0.00**			
Age (months)	1.00	0.01	0.64	1.01	0.01	0.36	1.02	0.01	0.27
Sex - boy	0.92	0.04	0.03	**0.88**	**0.04**	**0.01**	**0.87**	**0.06**	**0.03**
No. observations	9,280			12,322			4,102		

	Group B						**Group C**		
	NLSCY (Canada)			**QLSCD (Canada)**			**Gen-R (Neth.)**		
	OR	SE	p	OR	SE	p	OR	SE	p
Log equiv. household income (PPP$)	**1.6**	**0.1**	**0.0**	0.00	0.01	0.06	**2.14**	**0.23**	**0.00**
Log equiv. household income (PPP$) ^2				**1.39**	**0.22**	**0.04**			
Age (months)	1.0	0.0	0.4	1.02	0.02	0.23	0.98	0.01	0.12
Sex - boy	**0.8**	**0.1**	**0.0**	1.07	0.12	0.52	0.95	0.07	0.48
No. observations	5,234			1,549			2,890		

Figure 7-13: Predicted probability of having excellent health for children aged exactly 5 years living in a 2 parent, 2 child household, at different levels of household income (p5, p25, p50, p75, p95)







Chronic illness

a) by parental education

Preliminary bivariate analysis of parent-reported chronic illness by parental education category suggested that there was a negative gradient in the Group A cohort (Figure 7-14). In Group B, the picture was mixed. There was a steep gradient in the LSAC-K. In the QLSCD, the relationship varied considerably between girls and boys, with a steep negative gradient among girls, but suggestion of a positive gradient among boys. There was little evidence of a relationship between parental education and chronic illness (slope) in the NLSCY (Group B) or Group C cohort (ABIS).

Logistic regression models regressed chronic illness on parental education categories, age and sex (Table 7-7). These models confirm the patterns shown in bivariate analysis. Parental education was a significant predictor of chronic illness in the MCS, the LSAC-K and the QLSCD, but not the NLSCY or ABIS. In the QLSCD, there was a significant interaction between parental education and child sex. Boys had higher odds of having a parent-reported chronic disease in all the cohorts.

These patterns are illustrated in Figure 7-15, which shows the predicted probability of having a chronic illness, by parental education category, for children aged 5 years. These graphs show steep gradients in the MCS (Group A) and LSAC-K (Group B), no evidence of a gradient in the NLSCY (Group B) or ABIS (Group C), and different patterns for boys and girls in the QLSCD (Group B) (although confidence intervals are wide).

It is not possible to compare the level of chronic illness gradients due to differences in how the question was asked and which chronic conditions were included in each cohort. This is discussed further in chapter 8.

Figure 7-14: The proportion of children with chronic illness by parental education (unadjusted)

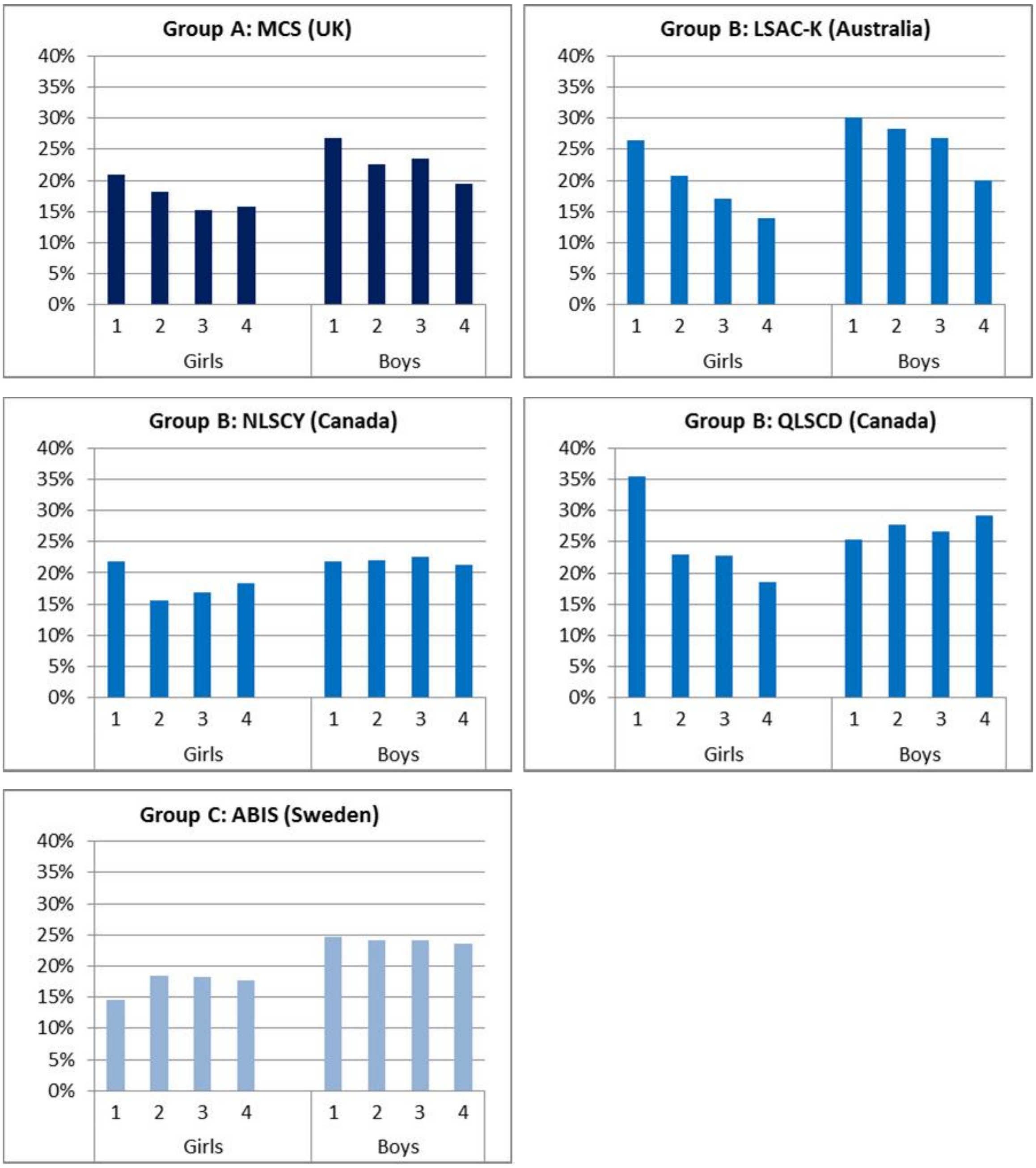
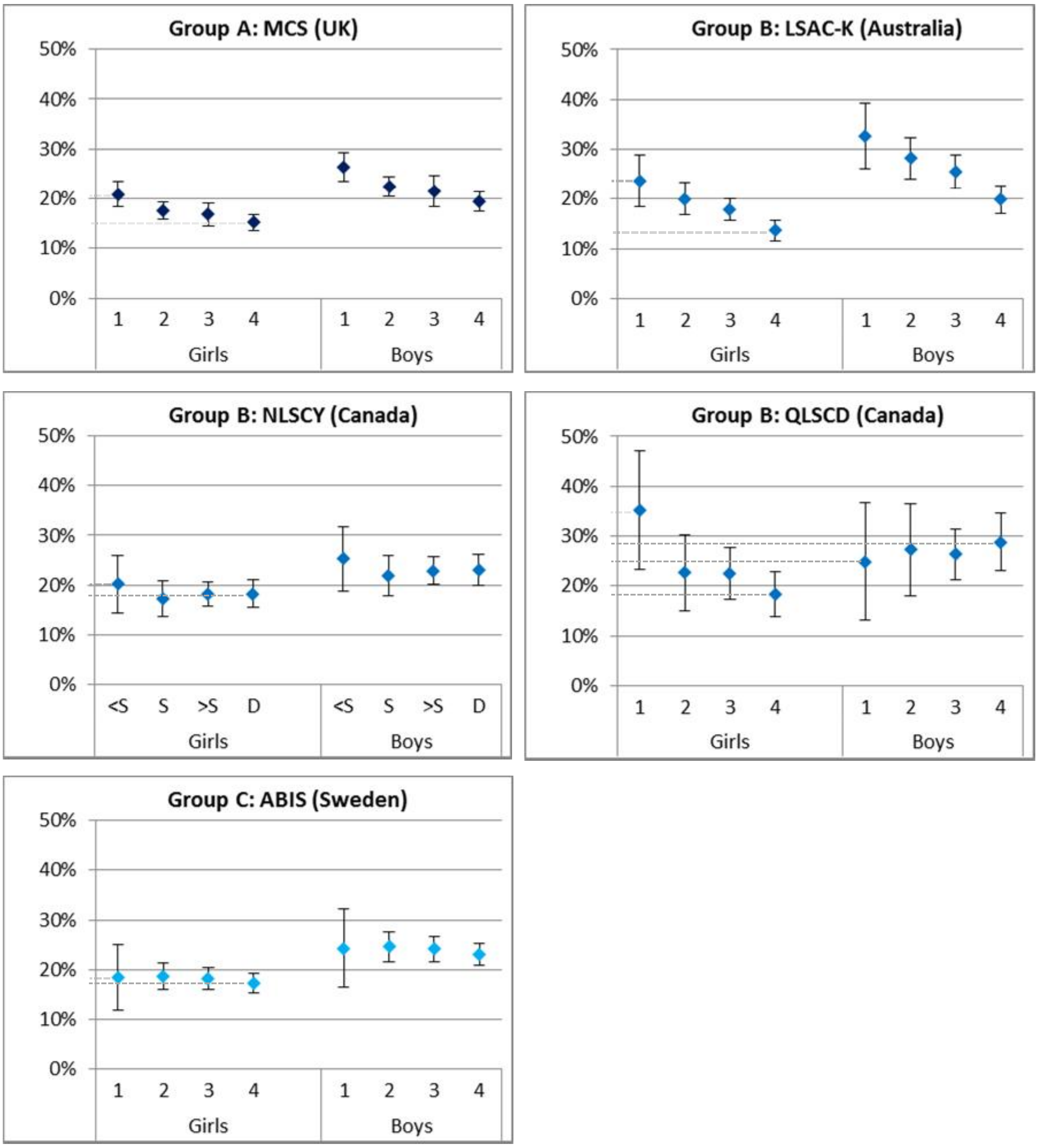


Table 7-7: Logistic regression models for chronic illness and parental education categories, age and sex

	Group A			Group B					
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)		
	OR	SE	p	OR	SE	p	OR	SE	p
Parental education									
Category 1	**1.48**	**0.13**	**0.00**	**1.96**	**0.29**	**0.00**	1.1	0.2	0.5
Category 2	**1.20**	**0.08**	**0.00**	**1.59**	**0.18**	**0.00**	0.9	0.1	0.6
Category 3	1.13	0.10	0.18	**1.38**	**0.13**	**0.00**	1.0	0.1	0.9
Category 4 (baseline)	1.00			1.00			1.0		
Difference between parental education categories			**0.00**			**0.00**			0.8
Age (months)	1.01	0.01	0.48	0.99	0.01	0.67	**1.0**	**0.0**	**0.0**
Sex - boy	**1.35**	**0.07**	**0.00**	**1.57**	**0.12**	**0.00**	**1.3**	**0.1**	**0.0**
No. observations	12,301			4,223			5,146		

	Group B			Group C		
	QLSCD (Canada)			ABIS (Sweden)		
	OR	SE	p	OR	SE	p
Parental education						
Category 1	**2.43**	**0.74**	**0.00**	1.07	0.23	0.75
Category 2	1.31	0.34	0.31	1.09	0.09	0.29
Category 3	1.30	0.27	0.22	1.06	0.07	0.38
Category 4 (baseline)	1.00			1.00		
Difference between parental education categories			**0.04**			0.69
Parental education * sex						
Category 1 * boy	**0.34**	**0.16**	**0.02**			
Category 2 * boy	0.71	0.27	0.36			
Category 3 * boy	0.68	0.19	0.17			
Age (months)	1.01	0.02	0.68	1.00	0.01	0.94
Sex - boy	**1.81**	**0.37**	**0.00**	**1.42**	**0.09**	**0.00**
No. observations	1,612			6,587		

Figure 7-15: Predicted probability of having a chronic illness for children aged exactly 5 years at different parental education levels



b) by household income

Preliminary bivariate analysis of chronic illness by household income suggested a similar pattern to that for parental education: there is evidence of a marked gradient by household income quintile in the Group A cohort. In Group B, there was a clear gradient in the LSAC-K, but little evidence of a gradient in either of the Canadian cohorts in this group (Figure 7-14).

Logistic regression models regressed chronic illness on continuous equivalised household income, age and sex. Equivalised household income was a significant predictor of chronic illness in the MCS, LSAC-K and NLSCY, however it was not significant in the QLSCD cohort. The graphs in Figure 7-17 show the predicted probability of having a chronic illness from these models, for children in households at different points on the income distribution. These graphs show steep, significant gradients in the MCS and LSAC-K. In the QLSCD cohort, there is no evident gradient in chronic illness by household income.

Figure 7-16: The proportion of children with chronic illness by equivalised household income quintile (unadjusted)

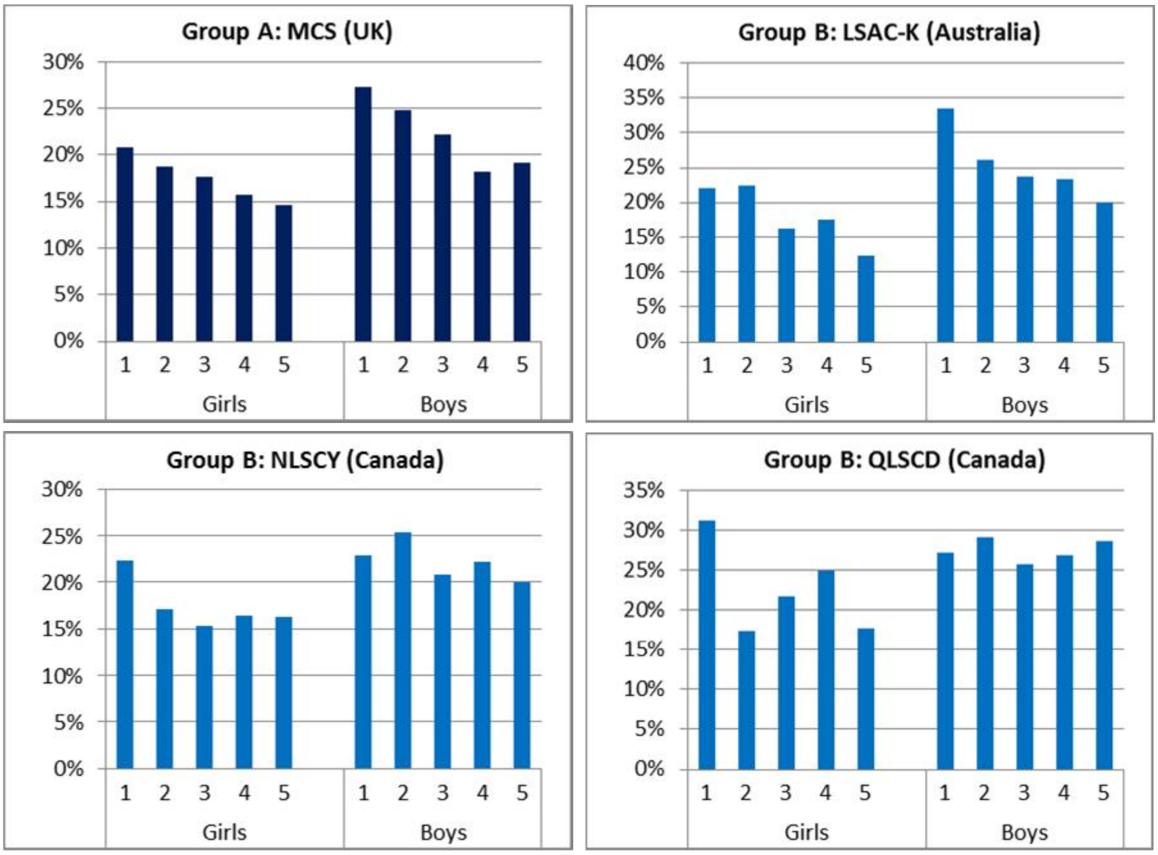
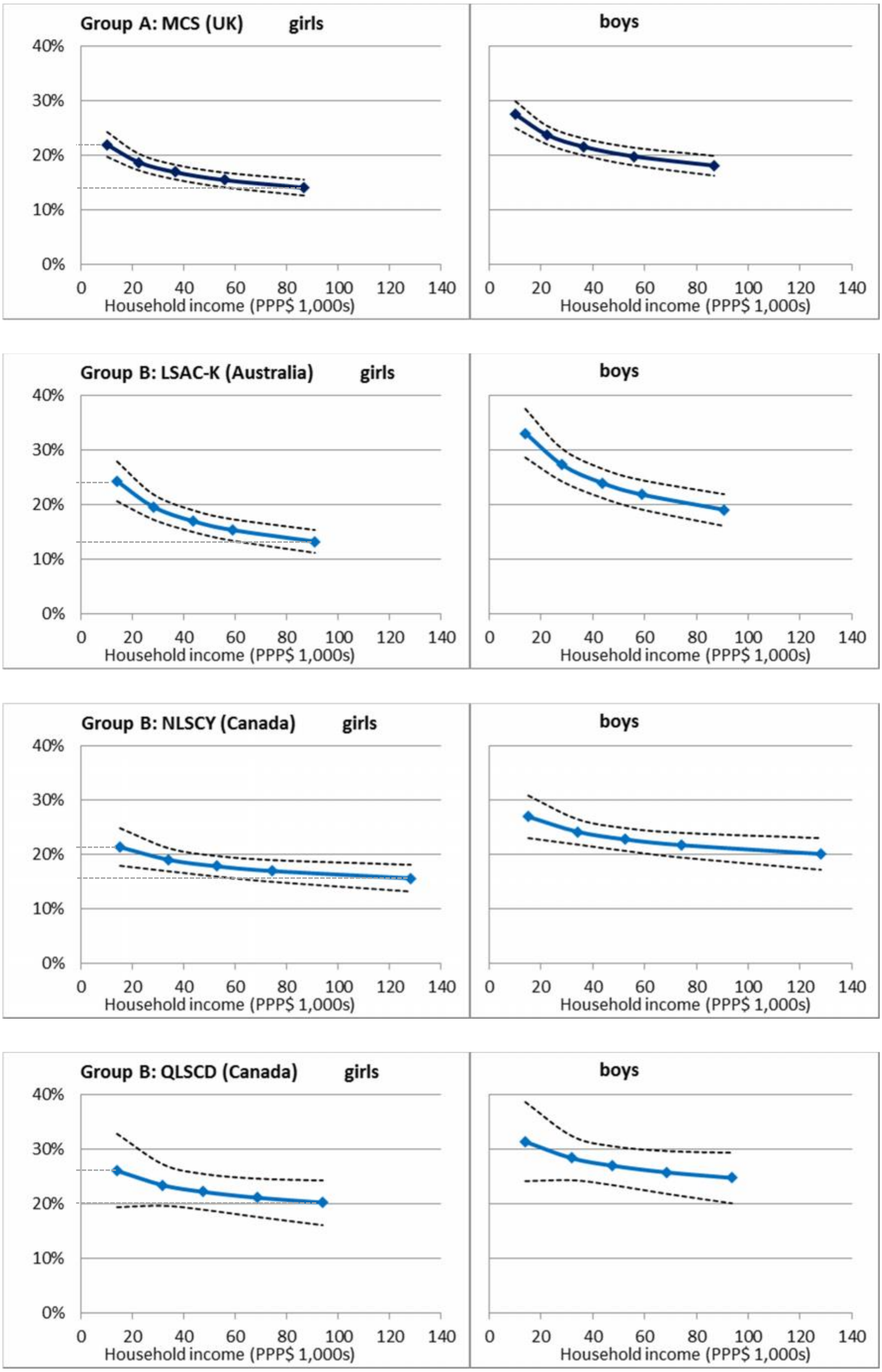


Table 7-8: Logistic regression models for chronic illness and continuous equivalised household income, age and sex

	Group A		
	MCS (UK)		
	OR	SE	p
Log equiv. household income (PPP$)	**0.78**	**0.03**	**0.00**
Age	1.01	0.01	0.48
Sex - boy	**1.35**	**0.07**	**0.00**
No. observations	12,316		

	Group B								
	LSAC-K (Australia)			NLSCY (Canada)			QLSCD (Canada)		
	OR	SE	p	OR	SE	p	OR	SE	p
Log equiv. household income (PPP$)	**0.67**	**0.05**	**0.00**	**0.8**	**0.1**	**0.0**	0.84	0.10	0.16
Age	1.00	0.02	0.85	**1.0**	**0.0**	**0.0**	1.01	0.02	0.75
Sex - boy	**1.55**	**0.12**	**0.00**	**1.4**	**0.1**	**0.0**	**1.30**	**0.16**	**0.04**
No. observations	4,103			5,235			1,549		

Figure 7-17: Predicted probability of chronic illness for children aged exactly 5 years living in a 2 parent, 2 child household, at different levels of household income (p5, p25, p50, p75, p95)



7.3. Behaviour and emotional development

Emotional problems and anxiety

a) by parental education

Mean standardised parent-reported emotional problems and anxiety scores by parental education are shown in Figure 7-18. As explained in chapter 5, there were considerable differences between cohorts in how emotional problems and anxiety were measured, so scores were standardised for comparison. Higher scores indicate higher levels of problems. These graphs suggest very steep gradients in the Group A cohort (MCS) and the Group C cohort (Gen-R). A steep gradient was also evident in one Group B cohort (LSAC-K), but gradients were less evident in the two cohorts from Canada. As emotional problem and anxiety scores have been standardised within each cohort, it is not possible to compare the level of problems between cohorts.

Emotional problems and anxiety scores were regressed on parental education, child age and sex (Table 7-9). Parental education was a highly significant predictor of emotional problems and anxiety in the MCS, LSAC-K and Gen-R and coefficients increased with each category of parental education. In the QLSCD, parental education was a significant predictor overall, but the coefficients did not suggest a stepwise gradient by parental education. Parental education was not a significant predictor in the NLSCY. The predicted emotional problems and anxiety scores for boys and girls aged 5 from these models are presented in Figure 7-19. These show very steep and significant gradients by parental education in Gen-R in particular, and also in the MCS and LSAC-K. Gradients were not evident in the predicted scores in the NLSCY and QLSCD cohorts.

It was not possible to compare the level of the gradients because different scales have been used and scores have been standardised around mean=0 in each cohort.

Figure 7-18: Mean standardised emotional problems and anxiety score by parental education (unadjusted)

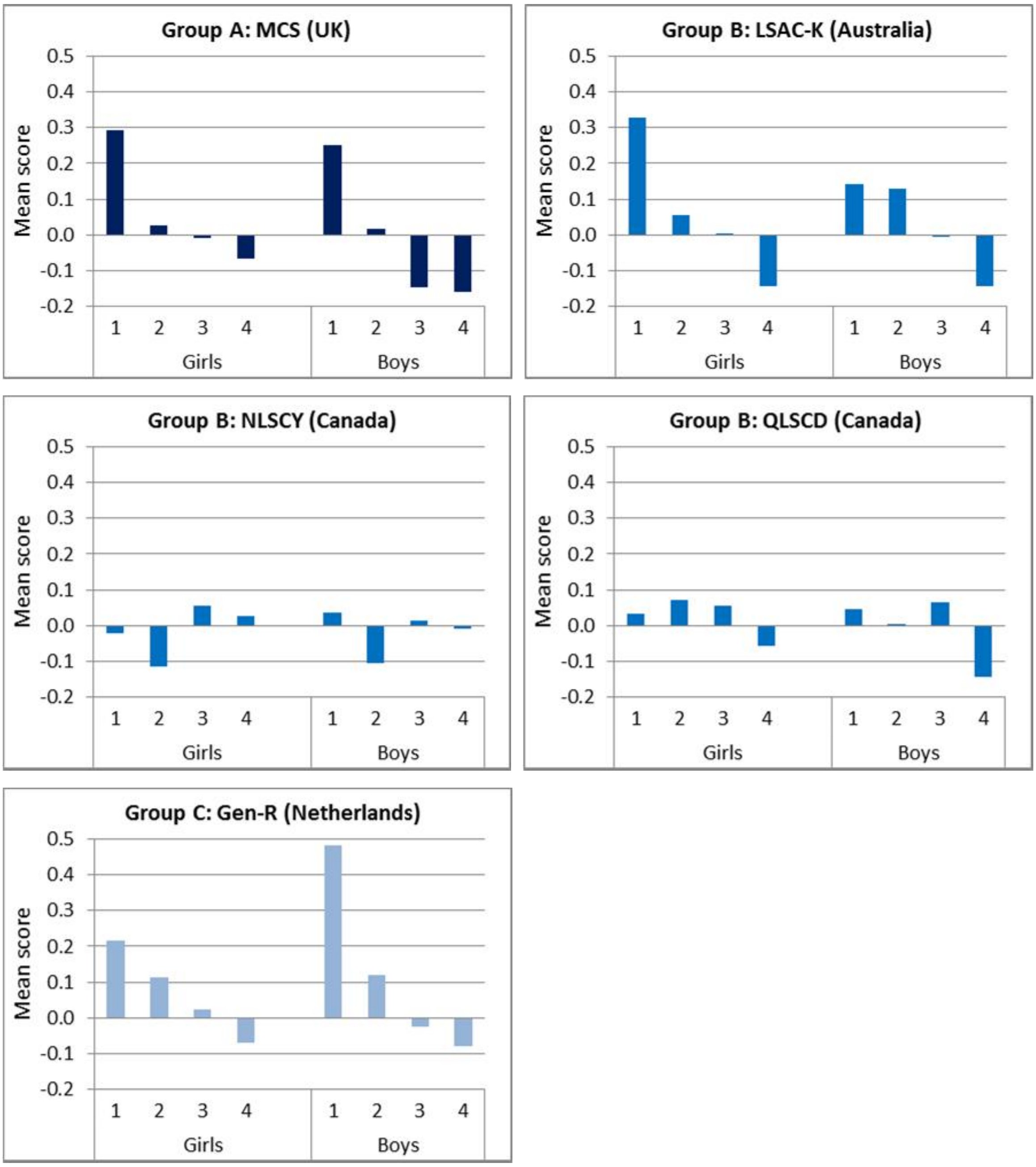
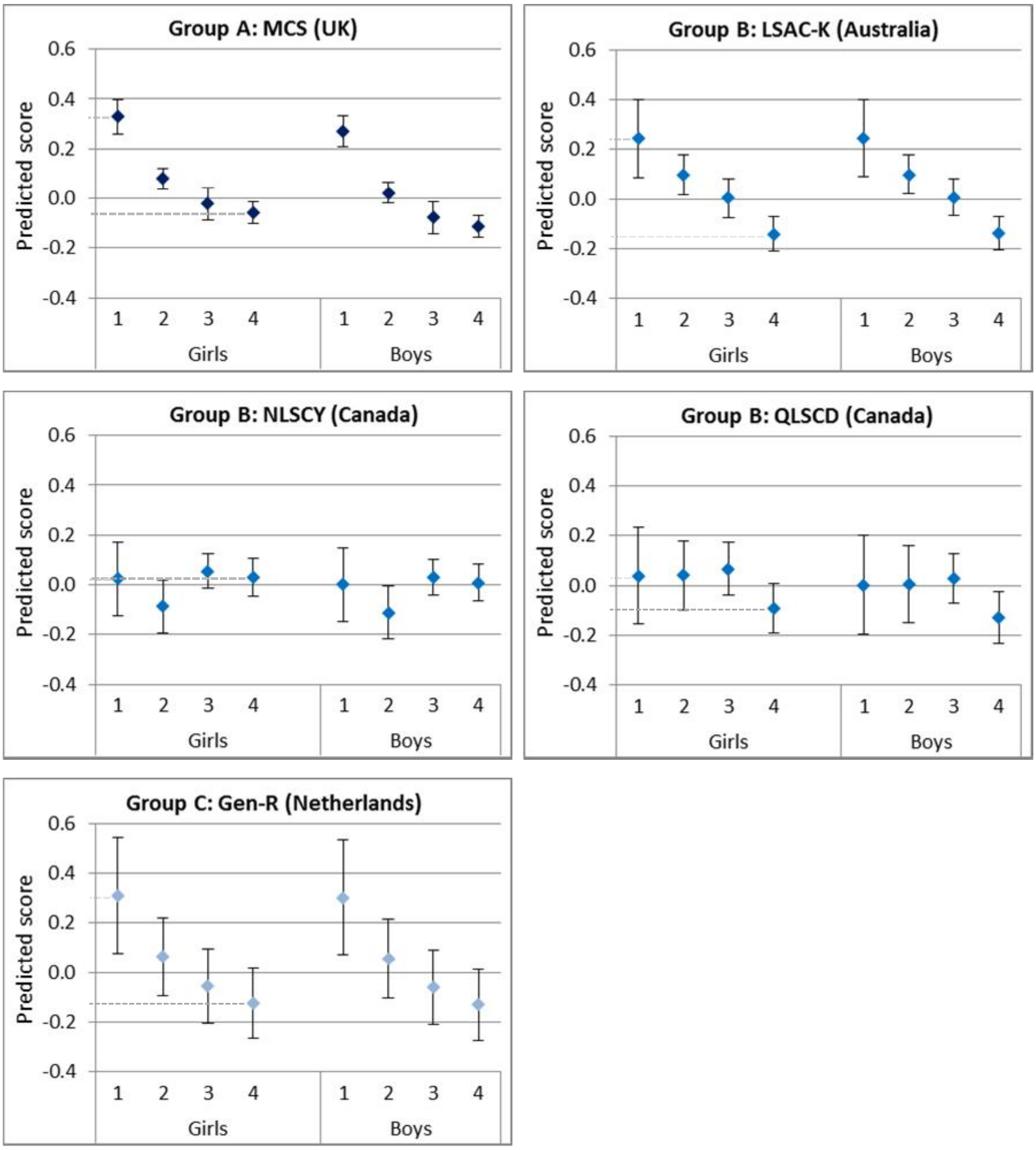


Table 7-9: Linear regression models for emotional problems score and parental education categories, age and sex

	Group A			**Group B**					
	MCS (UK)			**LSAC-K (Australia)**			**NLSCY (Canada)**		
	coef.	SE	p	coef.	SE	p	coef.	SE	p
Parental education									
Category 1	**0.39**	**0.03**	**0.00**	**0.4**	**0.1**	**0.0**	-0.0	0.1	0.9
Category 2	**0.14**	**0.02**	**0.00**	**0.2**	**0.0**	**0.0**	**-0.1**	**0.1**	**0.0**
Category 3	0.04	0.03	0.31	**0.1**	**0.0**	**0.0**	0.0	0.0	0.6
Category 4 (baseline)	0.00			0.0			0.0		
Difference between parental education categories			**0.00**			**0.0**			0.1
Age (months)	**-0.01**	**0.00**	**0.00**	0.0	0.0	0.8	0.0	0.0	0.3
Sex - boy	**-0.06**	**0.02**	**0.01**	0.0	0.0	0.9	-0.0	0.0	0.5
No. observations	12,201			4,217			5,154		
R2	0.02			0.01			0.0		

	Group B			**Group C**		
	QLSCD (Canada)			**Gen-R (Neth)**		
	coef.	SE	p	coef.	SE	p
Parental education						
Category 1	0.13	0.10	0.21	**0.43**	**0.09**	**0.00**
Category 2	0.13	0.08	0.10	**0.19**	**0.05**	**0.00**
Category 3	**0.16**	**0.06**	**0.01**	0.07	0.04	0.09
Category 4 (baseline)	0.00					
Difference between parental education categories			**0.05**			**0.00**
Age (months)	0.01	0.01	0.39	0.00	0.01	0.41
Sex - boy	-0.04	0.05	0.48	-0.01	0.03	0.85
No. observations	1,612			3,345		
R2	0.01			0.01		

Figure 7-19: Predicted standardised emotional problems and anxiety score for children aged exactly 5 years at different parental education levels



b) by household income

Preliminary bivariate analysis of emotional problems and anxiety by household income quintile showed a steep gradient in the Group A cohort (MCS). There was also evidence of gradients in the Group C cohort (Gen-R) and in the LSAC-K cohort (Group B) and, unlike the pattern for parental education, a gradient was also evident in the QLSCD. There was no clear gradient in the NLSCY.

Linear regression models, regressing emotional problems and anxiety on continuous, equivalised household income, child age and sex are presented in Table 7-10. The models confirm the bivariate analysis: equivalised household income was a significant predictor of emotional problems and anxiety in the MCS, LSAC-K, QLSCD and Gen-R, but not in the NLSCY. The predicted emotional problems and anxiety scores from these models are graphed in Figure 7-21. These graphs illustrate the steep gradients in the Group A cohort (MCS), two of the Group B cohorts (LSAC-K and QLSCD) and the Group C cohort (Gen-R). However, gradients were not evident in the NLSCY.

Figure 7-20: Mean standardised emotional problems and anxiety score by equivalised household income quintile (unadjusted)

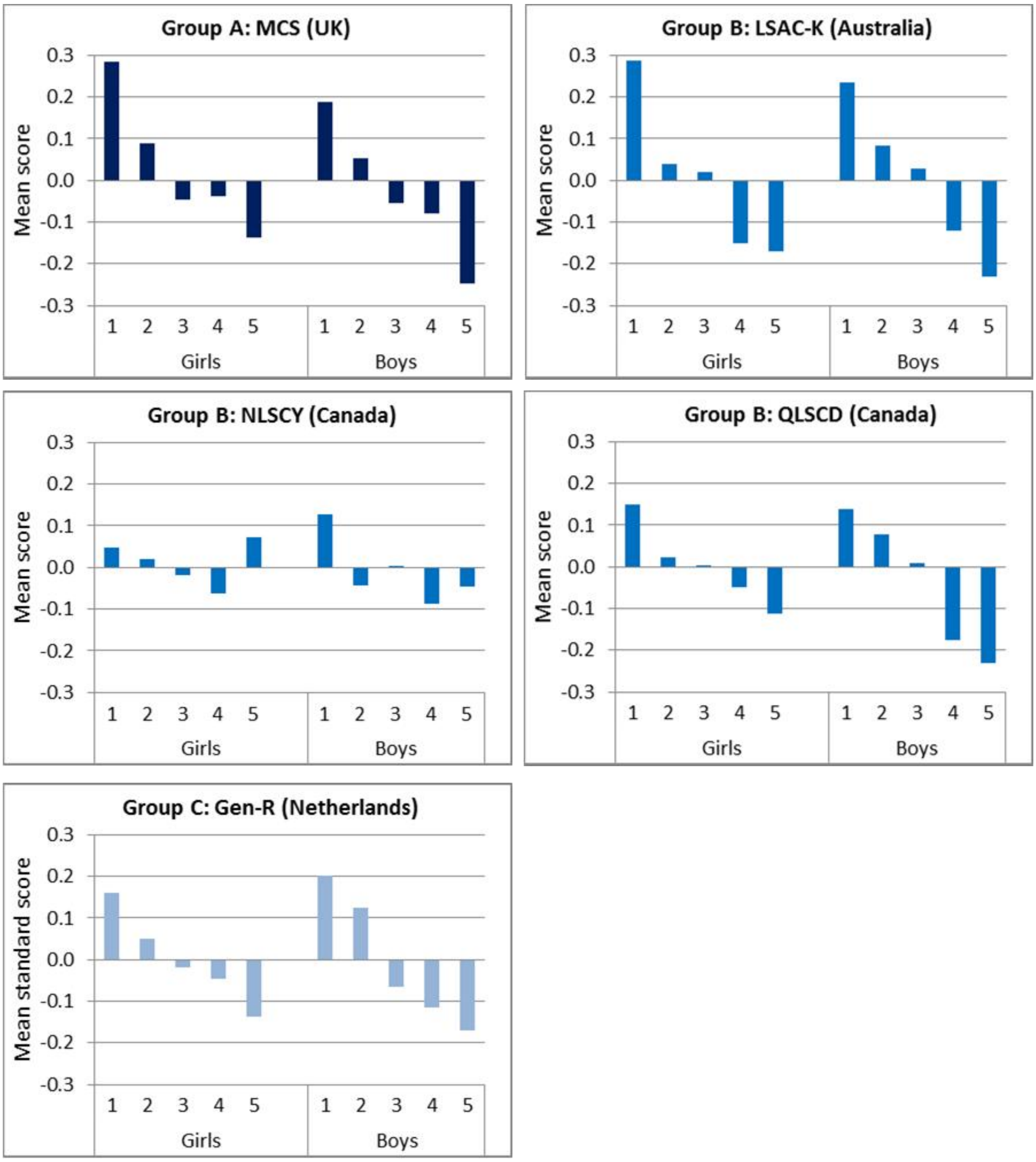


Table 7-10: Linear regression models for emotional problems and continuous equivalised household income, age and sex

	Group A			Group B					
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)		
	coef.	SE	p	coef.	SE	p	coef.	SE	p
Log equiv. household income (PPP$)	**-0.22**	**0.02**	**0.00**	**-0.29**	**0.03**	**0.00**	-0.1	0.0	0.1
Age (months)	**-0.01**	**0.00**	**0.00**	0.00	0.01	0.98	0.0	0.0	0.4
Sex - boy	**-0.06**	**0.02**	**0.00**	0.00	0.03	0.89	0.0	0.0	0.7
No. observations	12,221			4,097			5,231		
R2	0.02			0.03			0.00		

	Group B			Group C		
	QLSCD (Canada)			Gen-R (Neth.)		
	coef.	SE	p	coef.	SE	p
Log equiv. household income (PPP$)	**-0.20**	**0.05**	**0.00**	**-0.31**	**0.04**	**0.00**
Age (months)	0.00	0.01	0.68	0.01	0.01	0.33
Sex - boy	-0.04	0.05	0.48	-0.01	0.03	0.79
No. observations	1,549			3,294		
R2	0.01			0.01		

Figure 7-21: Predicted standardised emotional problems and anxiety score for children aged exactly 5 years living in a 2 parent, 2 child household, at different levels of household income (p5, p25, p50, p75, p95)

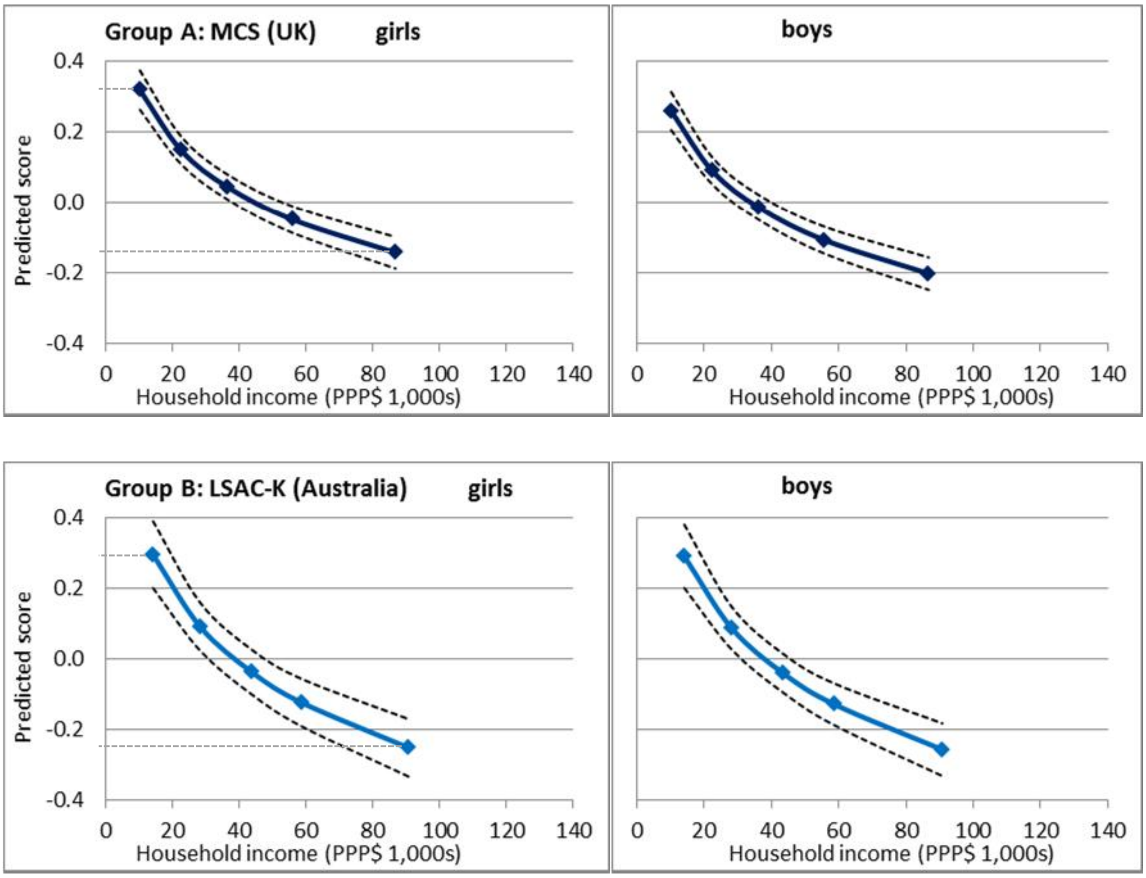
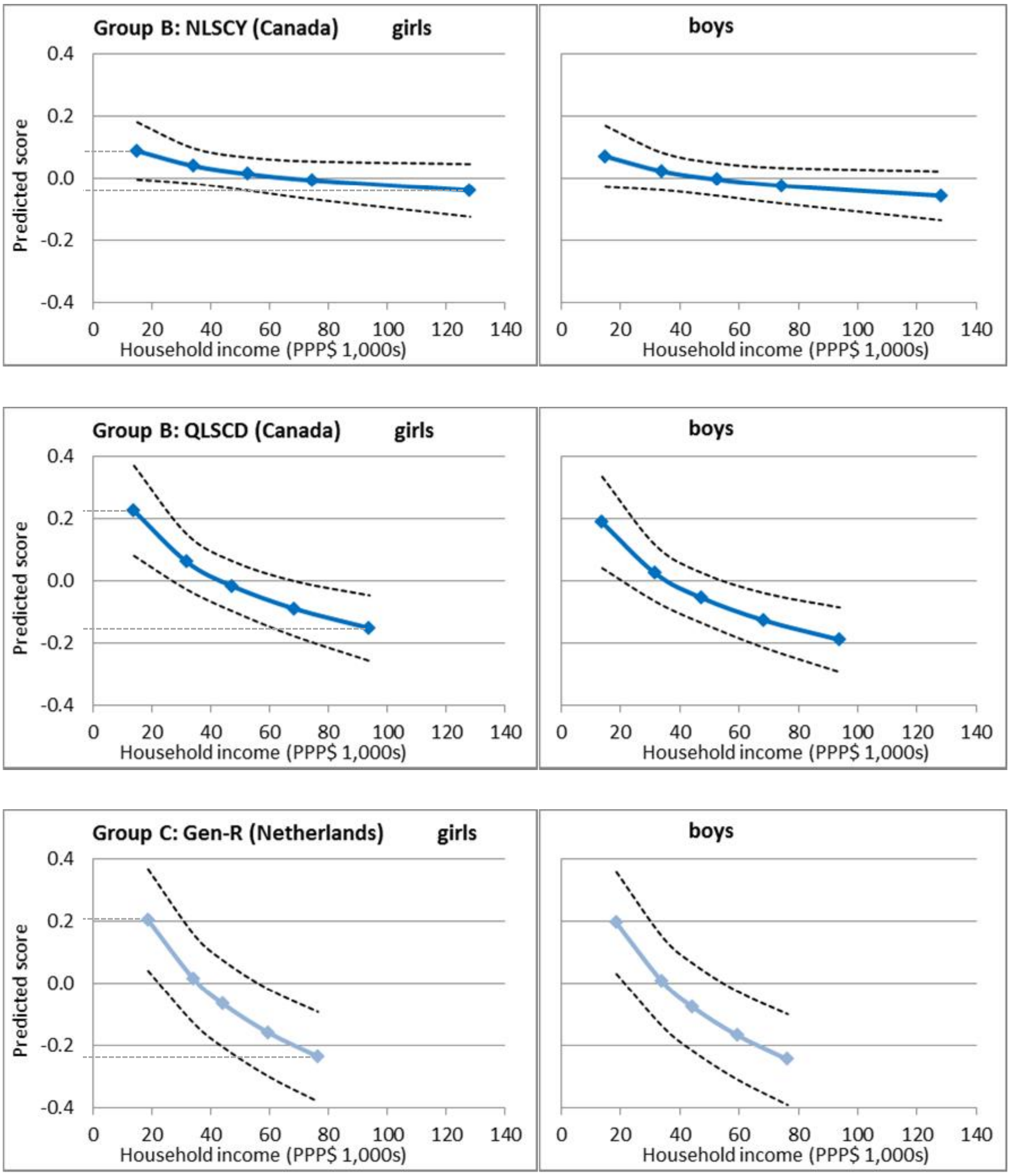


Figure 7-21 continued



Hyperactivity and inattention

a) by parental education

Mean standardised parent-reported hyperactivity scores for children in each parental education group are shown in Figure 7-22. As explained in chapter 5, there were considerable differences between cohorts in how hyperactivity and inattention were measured, so scores were standardised for comparison. Higher scores indicate higher levels of hyperactivity. There is a gradient in all the studies among girls and boys; gradients are steepest in the MCS and LSAC-K. It is not possible to compare the level of hyperactivity between studies, as scores were standardised in each cohort.

Hyperactivity scores were regressed on parental education, child age and sex using linear regression (Table 7-5). Parental education was a highly significant predictor of hyperactivity score in all the cohorts. In all cohorts, boys had significantly higher hyperactivity and inattention scores than girls, overall. The predicted hyperactivity scores from the models for children aged exactly 5 years with different levels of parental education are shown in Figure 7-23. These graphs illustrate gradients in hyperactivity by parental education in all of the cohorts. Gradients were steepest in the MCS and LSAC-K; confidence intervals were wide in the QLSCD.

Figure 7-22: Mean standardised hyperactivity and inattention score by parental education (unadjusted)

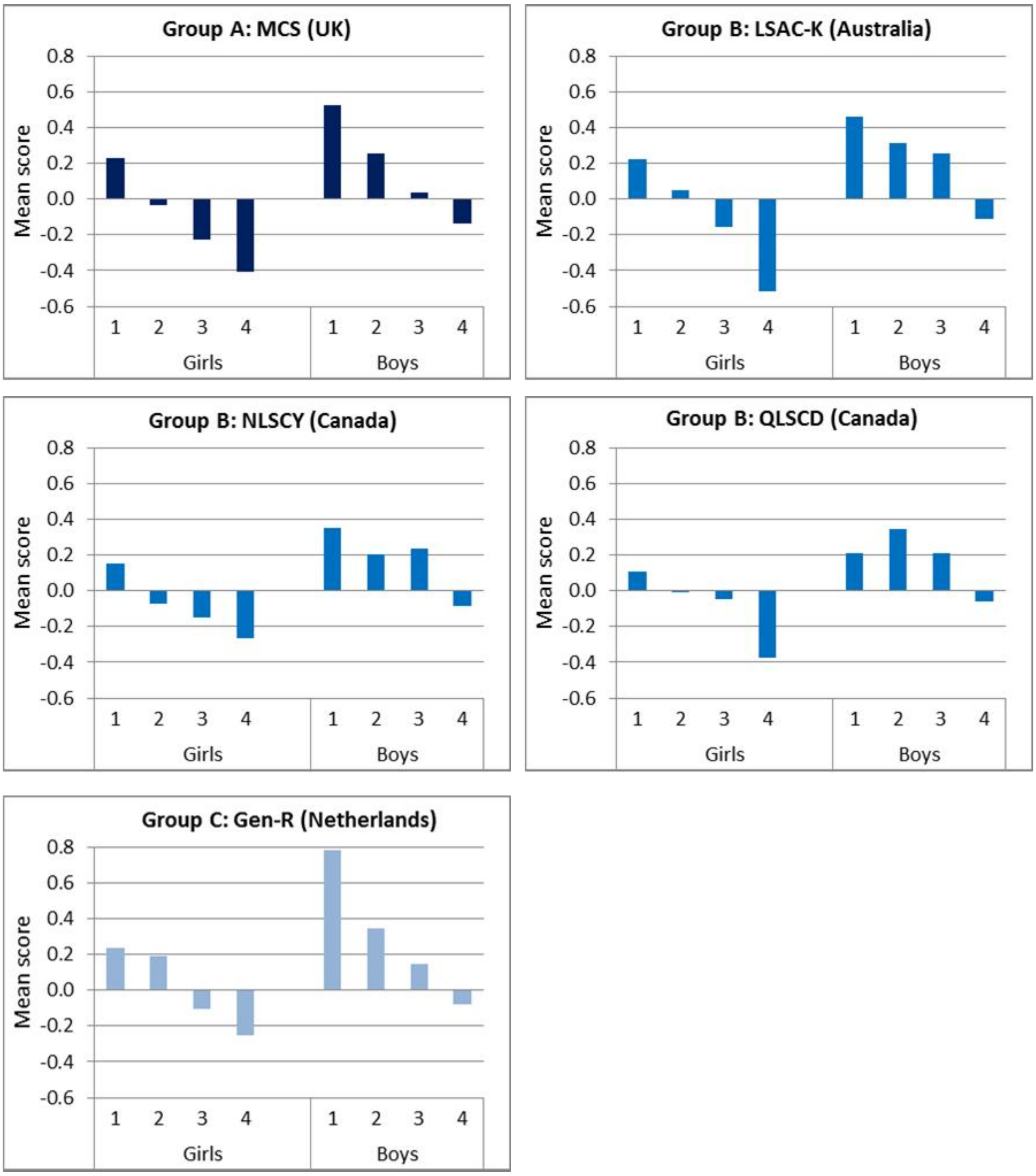
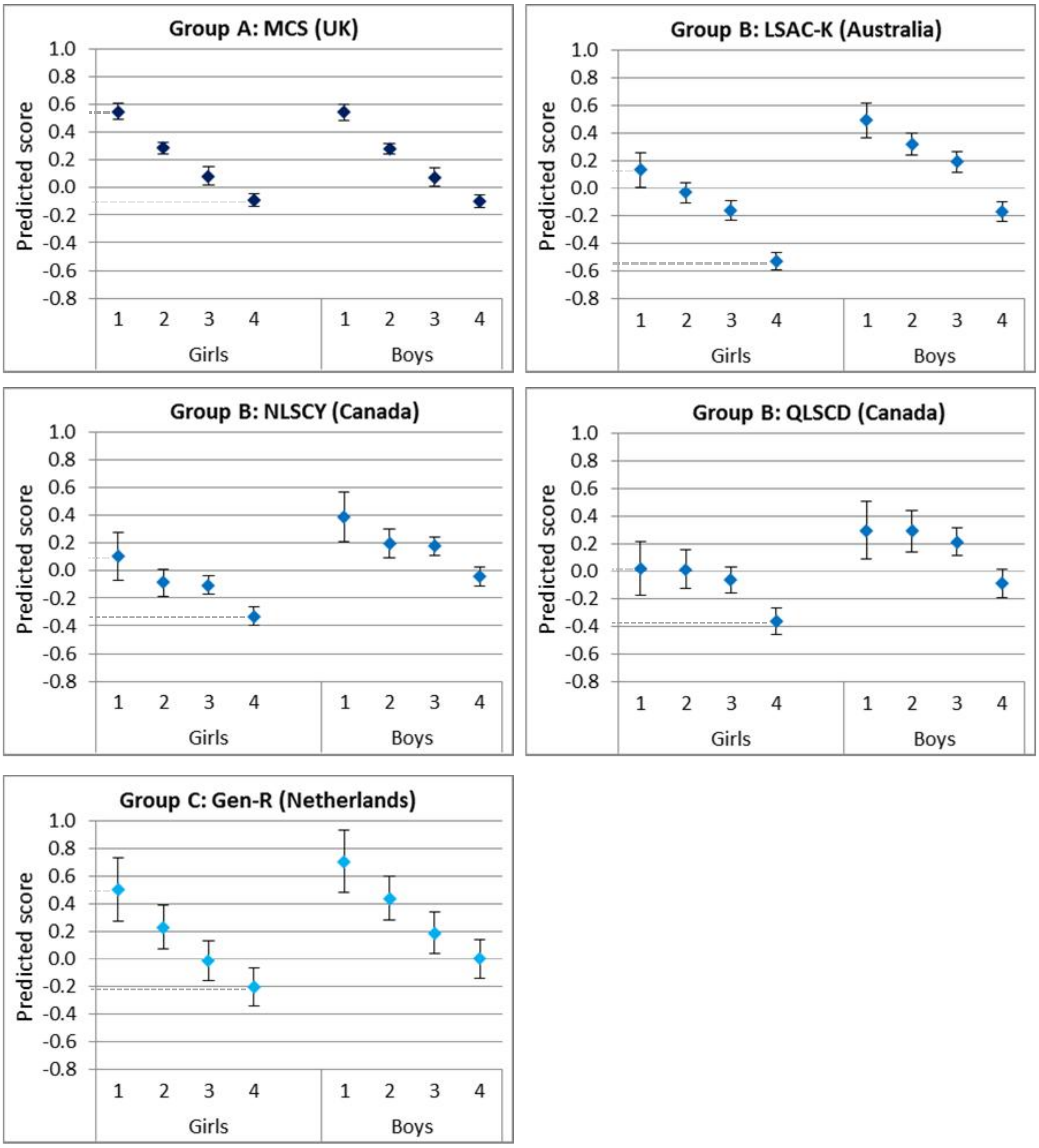


Table 7-11: Linear regression models for hyperactivity score and parental education categories, age and sex

	Group A			Group B					
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)		
	coef.	SE	p	coef.	SE	p	coef.	SE	p
Parental education									
Category 1	**0.65**	**0.03**	**0.00**	**0.66**	**0.07**	**0.00**	**0.4**	**0.1**	**0.0**
Category 2	**0.38**	**0.02**	**0.00**	**0.49**	**0.04**	**0.00**	**0.2**	**0.1**	**0.0**
Category 3	**0.18**	**0.03**	**0.00**	**0.36**	**0.04**	**0.00**	**0.2**	**0.0**	**0.0**
Category 4 (baseline)	0			0			0		
Difference between parental education categories			**0.00**			**0.00**			**0.0**
Age (months)	**-0.01**	**0.00**	**0.00**	**-0.01**	**0.01**	**0.04**	0.0	0.0	0.4
Sex - boy	**0.28**	**0.02**	**0.00**	**0.36**	**0.03**	**0.00**	**0.3**	**0.0**	**0.0**
No. observations	12,178			4,218			5,145		
R2	0.072			0.082			0.037		

	Group B			Group C		
	QLSCD (Canada)			Gen-R (Neth.)		
	coef.	SE	p	coef.	SE	p
Parental education						
Category 1	**0.38**	**0.11**	**0.00**	**0.70**	**0.09**	**0.00**
Category 2	**0.38**	**0.08**	**0.00**	**0.44**	**0.04**	**0.00**
Category 3	**0.30**	**0.06**	**0.00**	**0.19**	**0.04**	**0.00**
Category 4 (baseline)	0					
Difference between parental education categories			**0.00**			**0.00**
Age (months)	0.01	0.01	0.56	-0.01	0.01	0.33
Sex - boy	**0.28**	**0.05**	**0.00**	**0.2**	**0.0**	**0.0**
No. observations	1,612			3,343		
R2	0.05			0.05		

Figure 7-23: Predicted standardised hyperactivity score for children aged exactly 5 years at different parental education levels



b) by household income

Figure 7-24 shows the mean hyperactivity score for children in each equivalised household income quintile in the cohorts. Steep income gradients were evident in the Group A cohort (MCS) and two of the Group B cohorts (LSAC-K and QLSCD), however pattern in the NLSCY is less clear. A steep gradient was also evidence in the Group C cohort (Gen-R).

Linear regression models regressing hyperactivity score on continuous equivalised household income, child age and sex are summarised in Table 7-12. Equivalised household income was a significant predictor of hyperactivity score in all the cohorts. Child sex was also significant in all cohorts: boys scored higher hyperactivity and inattention scores on average. Figure 7-25 shows the predicted scores from these models, at different levels of household income. Marked, steep household income gradients in hyperactivity were evident among both girls and boys across all the cohorts.

Figure 7-24: Mean standardised hyperactivity and inattention score by equivalised household income quintile (unadjusted)

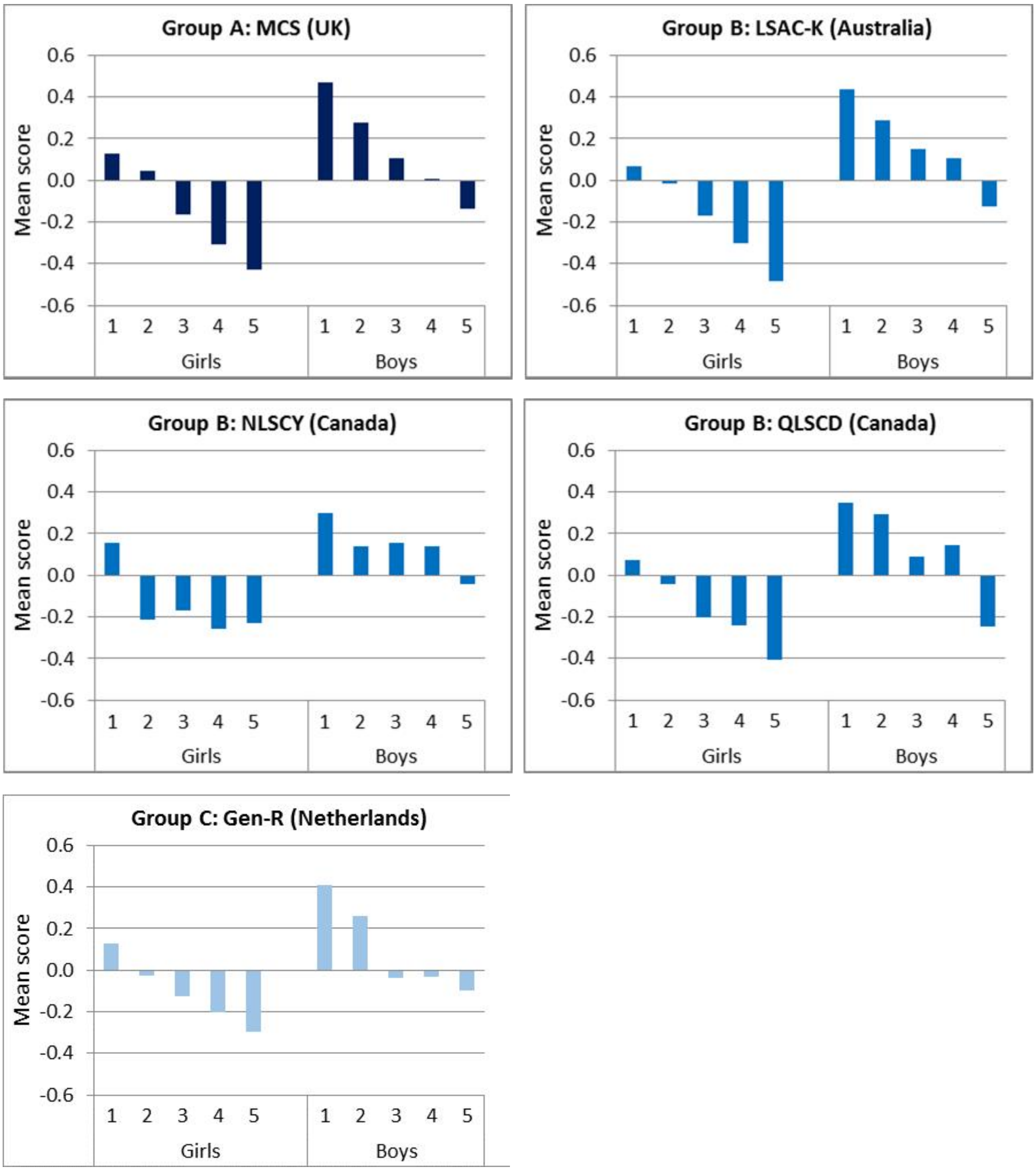
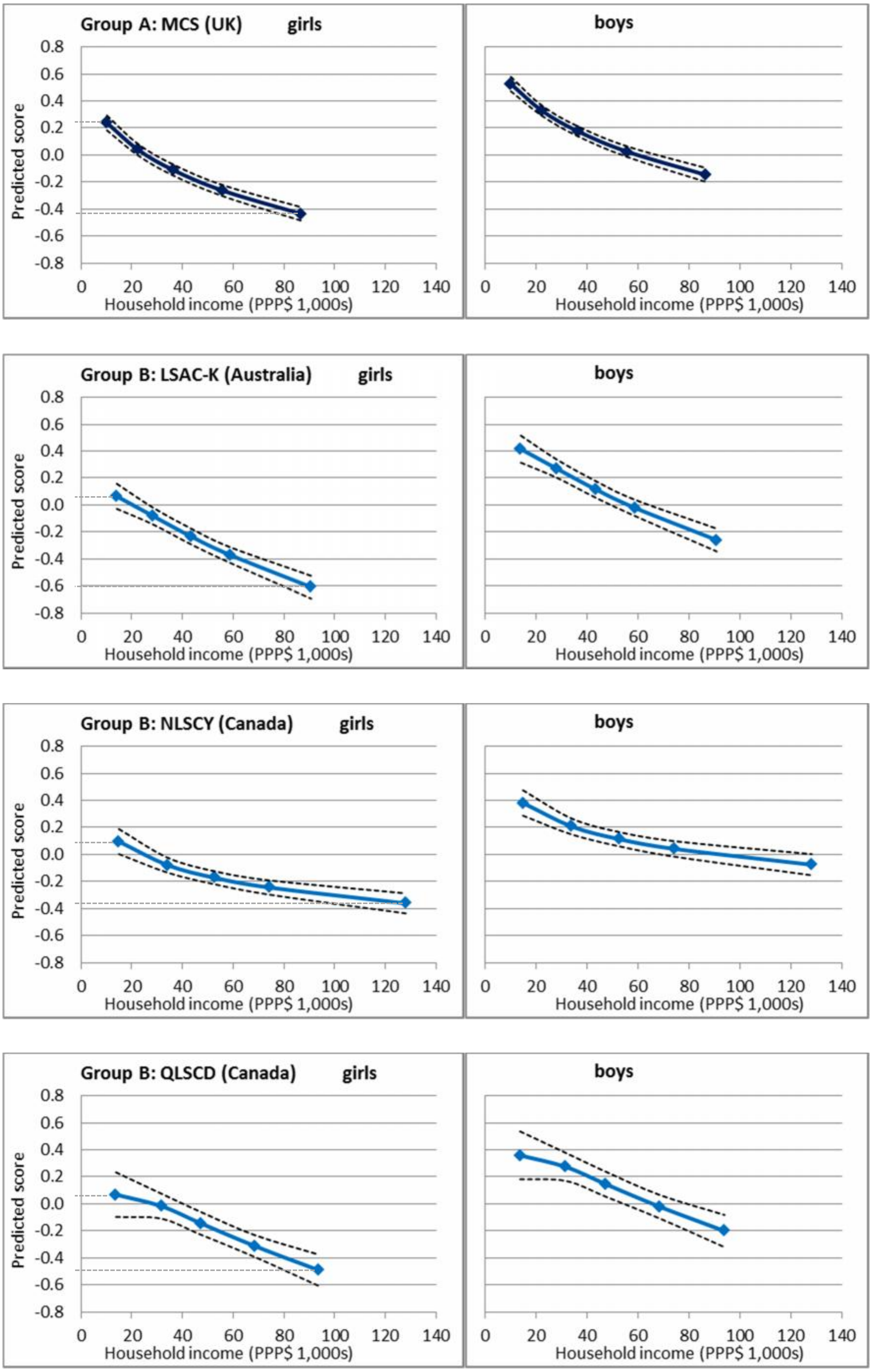


Table 7-12: Linear regression models for hyperactivity and continuous equivalised household income, age and sex

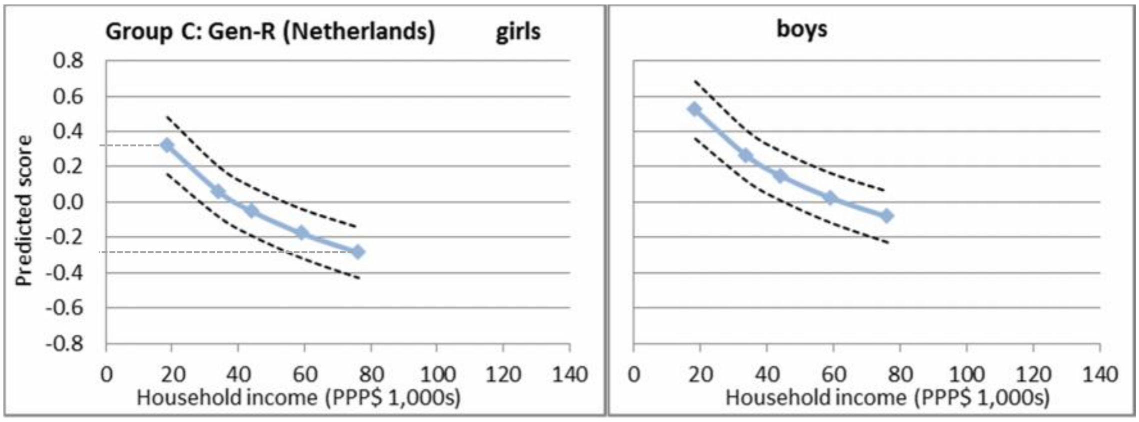
	Group A			Group B					
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)		
	coef.	se	p	coef.	se	p	coef.	se	p
Log equiv. household income (PPP$)	**0.56**	**0.28**	**0.04**	**2.20**	**0.79**	**0.01**	**-0.2**	**0.0**	**0.0**
Log equiv. household income (PPP$) ^2	**-0.05**	**0.01**	**0.00**	**-0.13**	**0.04**	**0.00**			
Age (months)	**-0.01**	**0.00**	**0.00**	**-0.01**	**0.01**	**0.03**	0.0	0.0	0.4
Sex - boy	**0.29**	**0.02**	**0.00**	**0.35**	**0.03**	**0.00**	**0.3**	**0.0**	**0.0**
No. observations	12,198			4,098			5,234		
R2	0.06			0.07			0.04		

	Group B			Group C		
	QLSCD (Canada)			Gen-R (Neth.)		
	coef.	se	p	coef.	se	p
Log equiv. household income (PPP$)	**3.12**	**1.38**	**0.02**	**-0.43**	**0.04**	**0.00**
Log equiv. household income (PPP$) ^2	**-0.17**	**0.07**	**0.01**			
Age (months)	0.00	0.01	0.71	0.00	0.01	0.40
Sex - boy	**0.29**	**0.05**	**0.00**	**0.20**	**0.03**	**0.00**
No. observations	1,549			3,292		
R2	0.05			0.04		

Figure 7-25: Predicted standardised hyperactivity score for children aged exactly 5 years living in a 2 parent, 2 child household, at different levels of household income (p5, p25, p50, p75, p95)



(Figure 7-25 continued)



7.4. Cognitive development

Verbal cognition

a) by parental education

Verbal cognition was measured using picture and language recognition tests. As these tests varied, scores were standardised for comparison. Mean standardised verbal cognition scores by parental education are presented in Figure 7-26. Higher scores indicate higher verbal cognitive ability. This preliminary analysis suggests a steep gradient in all cohorts.

These findings are confirmed in models regressing standardised verbal cognition scores on parental education, child age and sex (Table 7-13). Parental education was a significant predictor in all cohorts, from Group A and B. There was a sex difference: boys had significantly worse scores in all cohorts. The predicted scores for 5 year old children with different parental education levels are shown in Figure 7-27. These graphs confirm the steep gradients in cognition by parental education in all cohorts, from countries with both high and medium income inequality.

It is difficult to interpret and compare standardised scores. Verbal cognition is closely related to age: in the regression models, we can see that standardised cognition scores increased by approximately 0.06 standard deviation units per month of age. The age coefficients from each cohort were used to calculate the difference in verbal cognition scores between different parental education categories in terms of months. Figure 7-28 shows the predicted detriment in terms of number of months of normal development that children from each parental education category experience, relative to children from the top parental education category (degree or higher), using the regression coefficients. These numbers confirm the steep gradients in cognitive development. In the MCS, children whose parents do not have a secondary qualification were predicted to be over 14 months behind children who have at least one parent with a degree. In the LSAC-K, this figure was 12 months; in the NLSCY it was 9 months.

Figure 7-26: Mean standardised verbal cognition score by parental education (unadjusted)

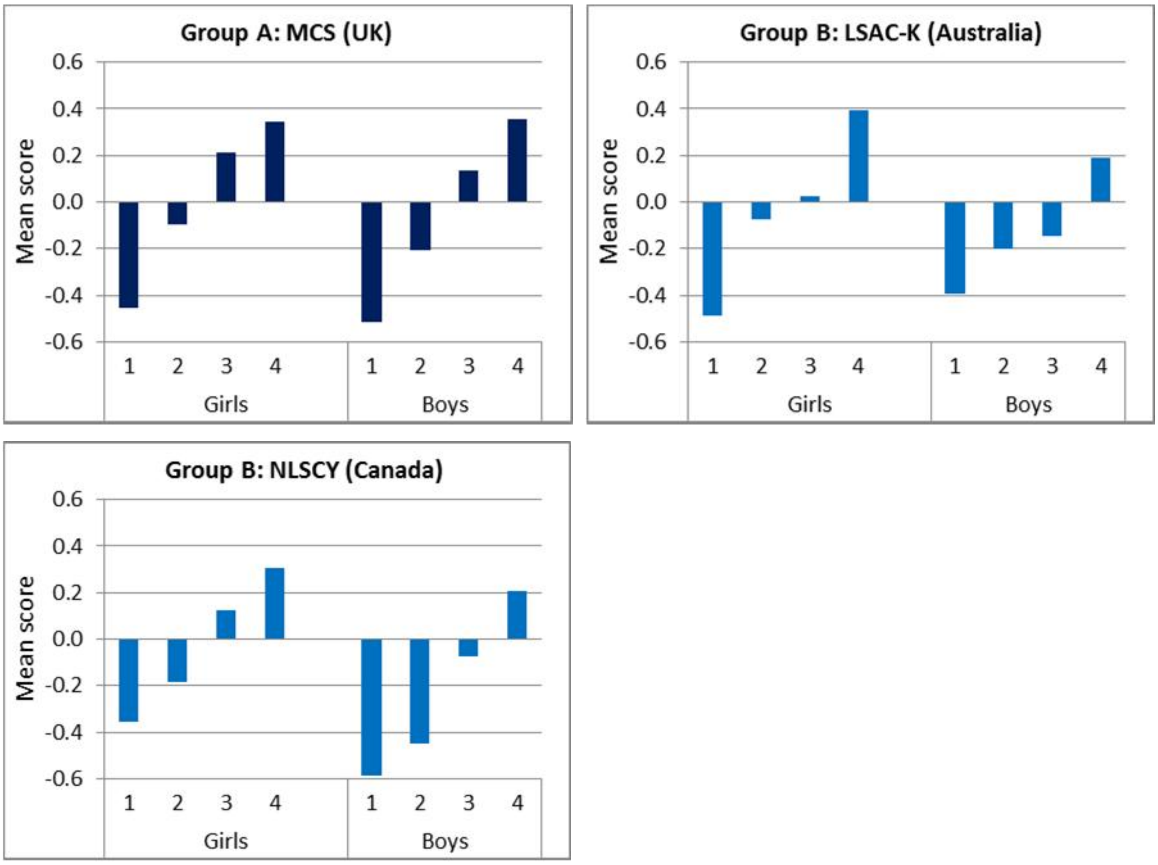


Table 7-13: Linear regression models for verbal cognition score and parental education categories, age and sex

	Group A			Group B					
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)		
	coef.	SE	p	coef.	SE	p	coef.	SE	p
Parental education									
Category 1	**-0.83**	**0.04**	**0.00**	**-0.75**	**0.08**	**0.00**	**-0.7**	**0.1**	**0.0**
Category 2	**-0.51**	**0.03**	**0.00**	**-0.43**	**0.05**	**0.00**	**-0.6**	**0.1**	**0.0**
Category 3	**-0.19**	**0.03**	**0.00**	**-0.36**	**0.04**	**0.00**	**-0.2**	**0.0**	**0.0**
Category 4 (baseline)	0.000			0.00			0.0		
Overall parental education			**0.00**			**0.00**			**0.0**
Age (month)	**0.06**	**0.00**	**0.00**	**0.06**	**0.01**	**0.00**	**0.1**	**0.0**	**0.0**
Sex - boy	**-0.06**	**0.02**	**0.01**	**-0.14**	**0.03**	**0.00**	**-0.2**	**0.0**	**0.0**
No. observations	12,159			3,781			4,787		
R2	0.116			0.080			0.165		

Figure 7-27: Predicted standardised verbal cognition score for children aged exactly 5 years at different parental education levels

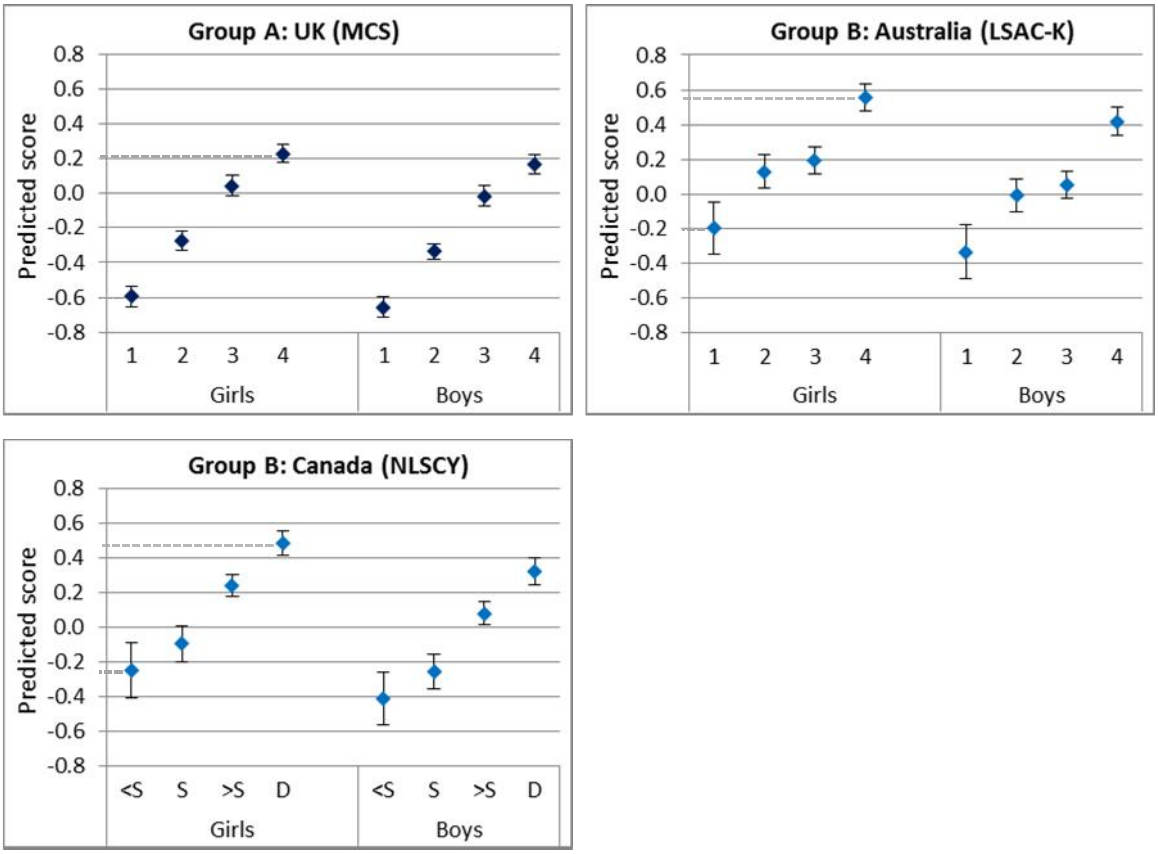


Figure 7-28: The difference in verbal cognition (in months of development) between parental education categories, by group and cohort

Parental education	Group A	Group B	
	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)
Category 1	-14.5 months	-12.0 months	-9.3 months
Category 2	-8.9 months	-6.8 months	-7.3 months
Category 3	-3.3 months	-5.8 months	-3.1 months
Category 4 (baseline)	-	-	-

b) by household income

The patterns of verbal cognition in relation to household income were similar to patterns by parental education. Mean standardised verbal cognition scores by equivalised parental education quintile are shown in Figure 7-29. There were marked gradients in all three cohorts from both Group A and Group B.

Models regressing standardised verbal cognition on continuous equivalised household income, age and sex are summarised in Table 7-14. Income was a significant predictor in all cohorts; sex and age were also significant. The predicted scores from these models for children from households at different points in the income distribution are shown in Figure 7-30. These figures illustrate the steep and significant gradients in all three cohorts.

As with parental education, differences in standardised verbal cognition scores between children at different points of the income distribution can be expressed in months of development. Figure 7-31 show the difference in verbal cognition, in terms of months of development, between children from households at the median income and other points on the income distribution (for children in 2 parent, 2 child households). The predicted difference between children from the top and bottom of the income distribution (p5 and p95) in the MCS was almost 15 months. In comparison, this figure was 12 months in the LSAC-K and much lower in the NLSCY, at 8.5 months. In interpreting these figures, we should bear in mind the differences in income distributions related to differences in measurement between the cohorts, however. It is difficult to know how much of this comparison is due to measurement differences. Some of these measurement differences particularly affect the tails of the distribution (e.g. top-coding), therefore it may be useful to compare outcomes at p25 and p75. These comparisons present a similar picture: children from households at the 25th percentile of the income distribution were predicted to be almost 7 months behind children from the 75th percentile in the MCS. In the LSAC-K, this difference was 5 months. Predictions from the NLSCY the difference was much lower – children from the 25th percentile were only 3 months behind children from the 75th percentile of household income.

Figure 7-29: Mean standardised verbal cognition score by equivalised household income quintile (unadjusted)

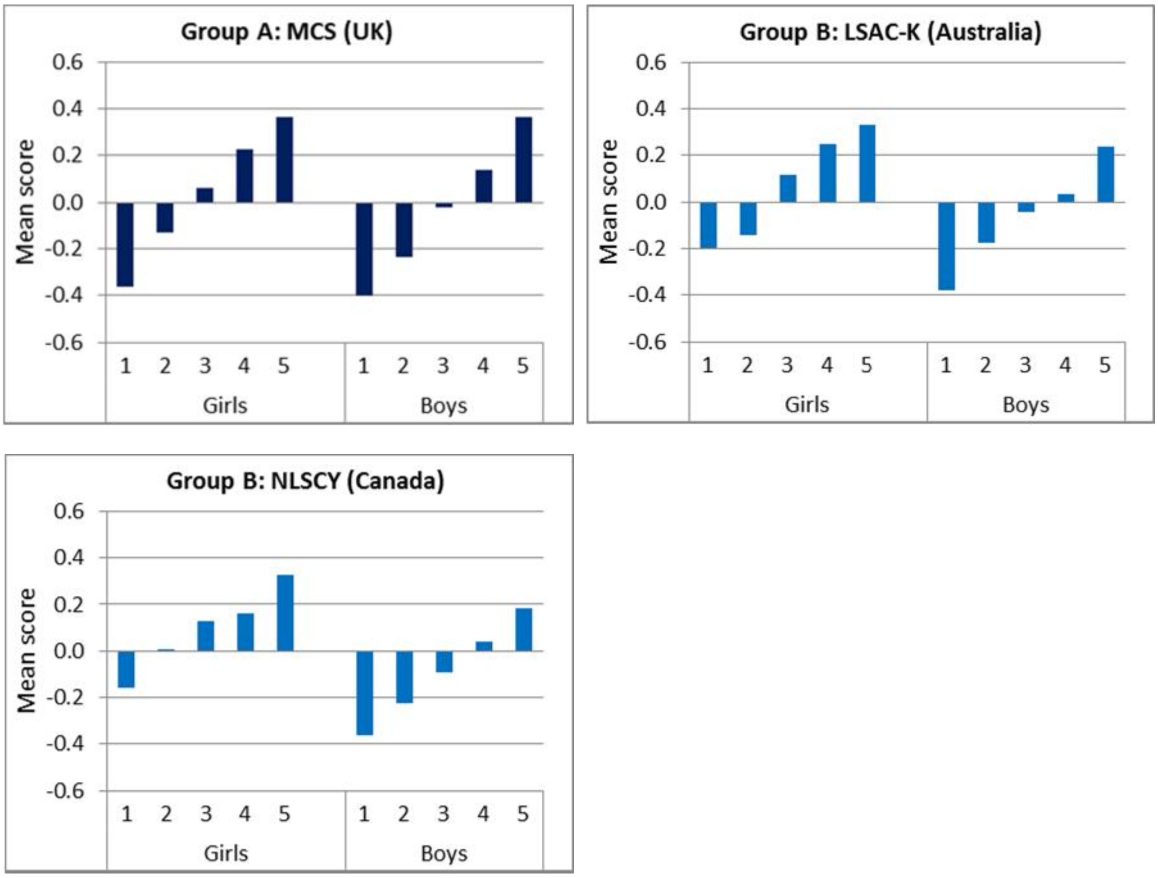


Table 7-14: Linear regression models for verbal cognition and continuous equivalised household income, age and sex

	Group A			Group B					
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)		
	coef.	SE	p	coef.	SE	p	coef.	SE	p
Log equiv. income (PPP$)	**-0.78**	**0.36**	**0.03**	**0.40**	**0.04**	**0.00**	**0.3**	**0.0**	**0.0**
Log equiv. income (PPP$) ^2	**0.06**	**0.02**	**0.00**						
Age	**0.06**	**0.00**	**0.00**	**0.06**	**0.01**	**0.00**	**0.1**	**0.0**	**0.0**
Sex - boy	**-0.06**	**0.02**	**0.01**	**-0.13**	**0.03**	**0.00**	**-0.2**	**0.0**	**0.0**
R2	0.098			0.074			0.148		
No. observations	12,145			3,686			4,832		

Figure 7-30: Predicted standardised verbal cognition score for children aged exactly 5 years living in a 2 parent, 2 child household, at different levels of household income (p5, p25, p50, p75, p95)

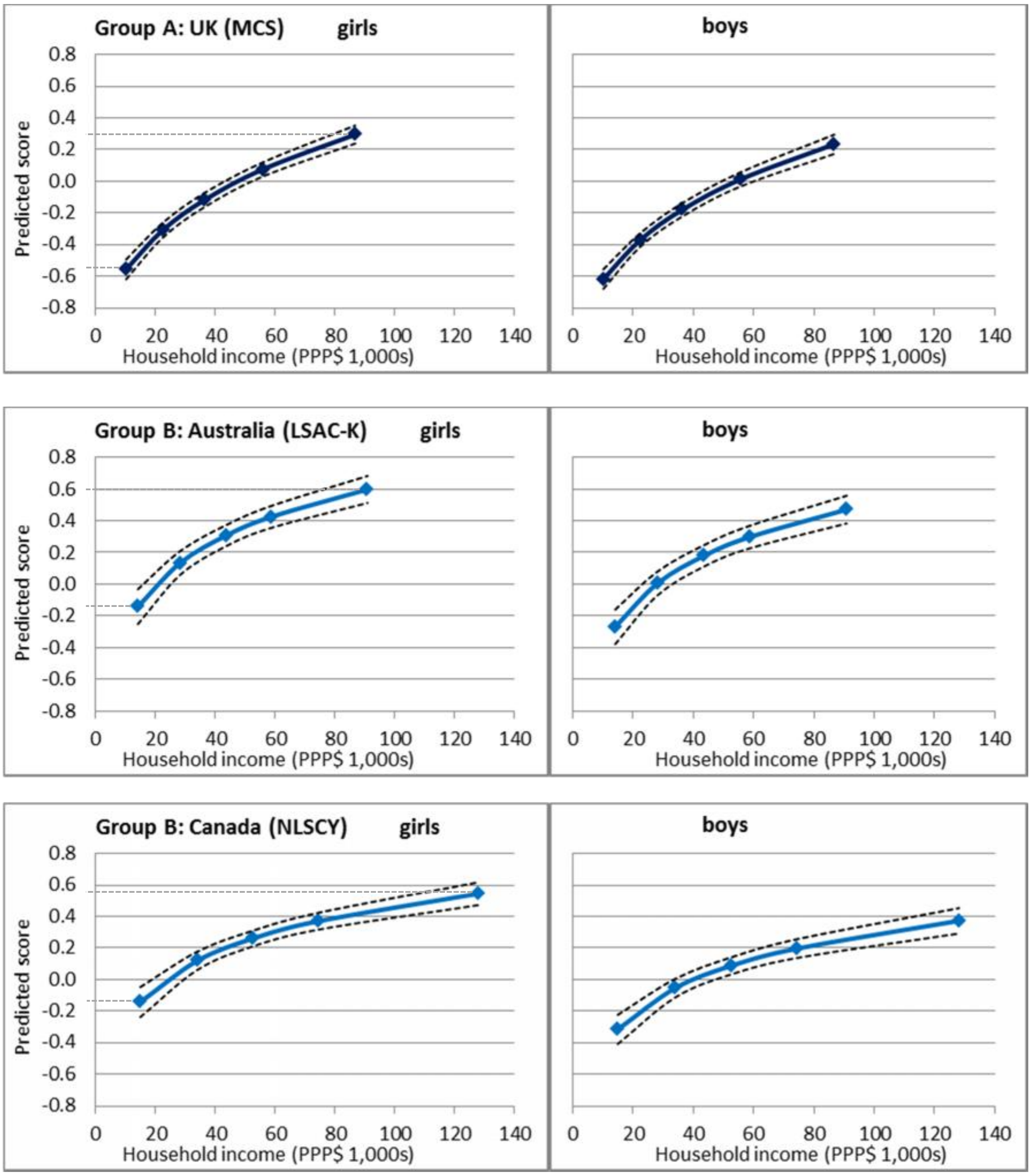


Figure 7-31: The difference in verbal cognition (in months of development) between children living in households at different points of the income distribution, by group and cohort

Point on the income distribution	Group A	Group B	
	MCS (UK)	**LSAC-K (Australia)**	**NLSCY (Canada)**
p5	-7.6 months	-7.4 months	-5.0 months
p25	-3.3 months	-2.9 months	-1.7 months
p50 (median)	0.0	0.0	0.0
p75	3.3 months	2.0 months	1.3 months
p95	7.1 months	4.8 months	3.5 months

Note: figures calculated for a child in a 2 parent, 2 child household at different points of the income distribution

7.5. Overview of findings by group and cohort

Group A

In Group A countries, the social gradient tended to be steep and significant.

In the ***MCS***, there was a steep, significant gradient in child health and development for every outcome. This was the case for analyses both by parental education and by household income. In comparisons between cohorts, gradients were often steepest in the MCS.

In the ***ECLS-K***, gradients were also evident for all outcomes, by parental education and household income. There was more variation relative to other cohorts. In comparison with Group B, gradients were steep for height and for excellent health. In the analysis of obesity, gradients by education were significant, but less steep than in the MCS.

In terms of level of outcome, there was some variation. Child height was shorter at every parental education level in both Group A countries than the Group B country (after controlling for age). In Group A, children from high parental education backgrounds had rates of excellent health similar to children from the NLSCY and LSAC-K. However, children from the low parental education groups were considerably less likely to have excellent health.

Group B

The picture in Group B was more complex than in Group A.

Of the three Group B cohorts, gradients were often steepest in the ***LSAC-K***; the level varied. There were steep gradients in relation to parental education level and household income for most outcomes (chronic illness, emotional problems and anxiety, hyperactivity and inattention, and verbal cognition). For height, social gradients were much shallower in relation to parental education in the LSAC-K than the group A countries. In terms of overweight/obesity, the level was high and there was a gradient in relation to parental education, but less evidence of a gradient in relation to household income. Excellent health differed - gradients were the shallowest in LSAC-K, and levels of parent-reported excellent health were high.

In the two Canadian cohorts, there was considerable variation. In the ***NLSCY***, steep gradients were observed for verbal cognition. Gradients were shallow compared to other cohorts for excellent health and chronic illness in relation to household income (but there was no gradient in relation to parental education) and hyperactivity and inattention. There was no gradient evident for emotional problems and inattention. In terms of the level, children were relatively healthy – the rate of chronic illness was relatively low, and the level of parent-reported excellent health was highest for nearly all socioeconomic groups.

In the ***QLSCD***, few outcomes showed significant gradients. Where they did, gradients were often shallower than other Group A and B cohorts. In terms of excellent health, there was a significant gradient by household income, but this pattern was less evident for parental education categories. There were also gradients in chronic illness by education and in hyperactivity and inattention (but the gradient by parental education was less steep than in Group A cohorts). The level of chronic illness was high in the QLSCD, and no gradients were apparent (by income); no gradients were apparent for emotional problems and anxiety.

Group C

In Group C, a very mixed pattern emerged.

In ***ABIS***, analyses were conducted for 3 outcomes, by parental education. The gradient in child height was flat in ABIS, except for the bottom parental education group, which fell behind other children. The level was higher – children were taller, on average, in all parental education groups than children in comparable parental education groups in other cohorts. A similar pattern emerged for chronic conditions: the gradient in chronic conditions by parental education was flat. However, a different picture was evident for obesity, with a steep, significant gradient.

Gen-R had some surprising results. There were significant social gradients for all outcomes analysed, which were often very steep. This was evident both in relation to parental education and household income. In circumstances where the level could be compared, mixed findings emerged. Children were tallest and least likely to be obese in Gen-R (at all parental education/income points, in relation to children in comparable circumstances in other cohorts), however parents reported very low levels of excellent health for children in Gen-R.

Overall, the gradients are most consistent, significant and steep in the Group A cohorts. In Group B, gradients were often (but not always) shallower. Within Group B, gradients are often steepest in the LSAC-K. In Group C there was a mixed picture: gradients were often flatter in ABIS than other cohorts, however, gradients were consistently significant and often very steep in Gen-R. There were considerable variations in the level of the gradient. The possible explanations for these different patterns are discussed in chapter 8.

7.6. Summary of chapter 7

This chapter presented social gradients in child health and development in the cohort studies.

1) Overall, findings on social gradients in child health and development in relation to income inequality were mixed, with considerable variation between outcomes and cohorts.
2) For child ***height***, a 'fanning out' effect was evident in relation to parental education: the gradient in height was shallower and children were taller in more equal countries. The picture was more difficult to compare in relation to parental income: gradients were evident in all cohorts, although the gap between height of children at the top and bottom of the household income spectrum was smaller and children were taller in the cohorts from more equal countries.
3) Gradients in child ***overweight and obesity*** were evident in all cohorts - the gradient was not related to the level of income inequality. This was true both by parental education and household income. The prevalence of overweight/obesity was lowest in the Group C cohorts.
4) Gradients in parent-reported ***excellent health*** were evident in the Group A cohorts. The picture was mixed in Group B, with gradients most evident in the NLSCY. In the Group C cohort, there was also a steep gradient. The level of parent reported excellent health had a very mixed pattern. Parents were least likely to report their children to be in excellent health in the Group C cohort, at all parental education/income levels.
5) For ***chronic illnesses***, there were some differences in gradients that seemed to relate to levels of income inequality. Gradients were clear and consistent in the Group A cohort and in one Group B cohort (LSAC-K), however gradients were shallower and less defined in the other Group B cohorts. No gradient by parental education was evident in ABIS. It was not possible to compare the level due to measurement differences between cohorts.
6) There were steep and significant gradients in child ***emotional problems and anxiety*** in all cohorts analysed, except the NLSCY (and QLSCD for parental education). The Group A cohort, Group C cohort and LSAC-K and QLSCD (for income) showed steep and significant gradients. Emotional problem and anxiety scores had been standardised, so it was not possible to compare the level of the gradient.
7) There were steep and significant gradients in child ***hyperactivity and inattention*** in all cohorts analysed. These gradients were evident by parental education and household income. Scores had been standardised, so it was not possible to compare the level of the gradient.

8) For ***verbal cognition***, steep gradients were evident in all 3 cohorts analysed (MCS, LSAC-K and NLSCY). The slopes varied in a pattern that was consistent with the level of income inequality in the country. Standardised scores were converted into 'months of development' for comparison: children from lower parental education of household income backgrounds fell further behind their peers in the most unequal country (MCS). It was not possible to compare the level of standardised scores.
9) The reasons for these differences in social gradients are discussed in chapter 8.

Chapter 8: Comparative cohort analysis - Discussion

This section discusses the findings from the comparative cohort analysis of social gradients in child health and development in relation to income inequality. The chapter starts with discussion of the validity of findings and comparisons between the cohorts. This includes consideration of differences between the cohorts, harmonisation and analysis approaches. The second part of the chapter considers whether there are any possible alternative explanations for the different patterns between cohorts. The chapter finishes with a summary of the limitations of the comparative cohort analysis.

8.1. Introduction

Findings from the comparative cohort analysis allow us to compare the gradients in children's health and development, by parental education and household income, between cohorts from countries at different levels of income inequality. In order to interpret these findings, we need to consider two key questions:

1) Are the differences in social gradients in child health and development that I have found valid?
2) Do differences in income inequality between countries explain these differences in the social gradient?

I consider these questions, reflecting on the harmonisation and analysis approaches used, and interpreting findings in relation to previous literature. These discussions provide a detailed consideration of the limitations of my study, which I summarise at the end of the chapter.

8.2. Validity of comparisons

As discussed in chapter 5, when we compare data from multiple datasets, observed similarities and differences may be due to:

a) methodological differences between the studies
b) errors in the comparative method, or
c) actual population differences (Bath et al., 2010)

It is important to consider the extent to which methodological differences between the studies and my choices of harmonisation and analysis methods could have affected the findings. Although I harmonised the samples and variables in each cohort in order to improve comparability, it was not possible to remove all differences.

I also compare my findings on each child health/development outcome with previous literature, in terms of social gradients and the relationship with income inequality. Consideration of the level of consistency with previous studies also helps us to assess validity of the findings and whether they reflect real population differences between countries. Throughout this section, I consider the differences in the 5 key ways that the datasets differ, outlined in chapter 5: sampling and response, other design features, measurement, context and history, and data management.

Cohort samples

There were considerable differences in the initial samples for each cohort. I improved comparability by defining a sample of: singleton children aged 4-6 from the majority ethnic group who were born in the country in which the cohort took place. However, there remain a number of differences that we need to take into account.

Geography of samples (national or regional)

I wanted to compare data from national samples, to reflect previous findings that income inequality in large areas (at the national/province level) is most relevant for health and wellbeing (Wilkinson and Pickett, 2006). The MCS, ECLS-K, LSAC-K and NLSCY aimed to provide a nationally representative sample (with some exclusions). However, other cohorts represented regions or cities. The QLSCD aimed to be representative of Quebec province, ABIS aimed to represent babies in southeast Sweden and Gen-R aimed to represented babies born in Rotterdam. This has a number of implications.

First, findings from these samples may differ from findings that would be achieved from nationally representative cohorts. Quebec province, for example has a different policy context from other Canadian provinces. Rotterdam is very different from other parts of the Netherlands (Box 8-1). ABIS, however, is less different from Sweden as a whole, as it sampled from a large, varied region with urban and rural areas (although Sweden is highly decentralised, so there may be differences in policy and service provision).

Second, the national level of income inequality may be inappropriate for these samples. Findings from Gen-R, in particular, need to be interpreted with this in mind. Gen-R is from a single city, Rotterdam, which is relatively unequal and poor in relation to other parts of the Netherlands (see Box 8-1). Rotterdam is a port city with a large industrial base and a high proportion of residents who are immigrants (GGD Rotterdam-Rijnmond, 2011). It differs in many ways from other parts of the Netherlands and findings therefore cannot be considered as a representative of patterns across the country as a whole. The Gini coefficient in Rotterdam lies between 0.3 and 0.35 (see Box 8-1). I made the decisions to classify Gen-R as a Group C cohort, using the national-level Gini coefficient (SWIID data). Given the higher level of income inequality in Rotterdam, perhaps Gen-R should have been included in Group B for analysis (although the figure on income inequality is unlikely to be comparable to SWIID figures).

Box 8-1: Socio-demographic characteristics of Rotterdam

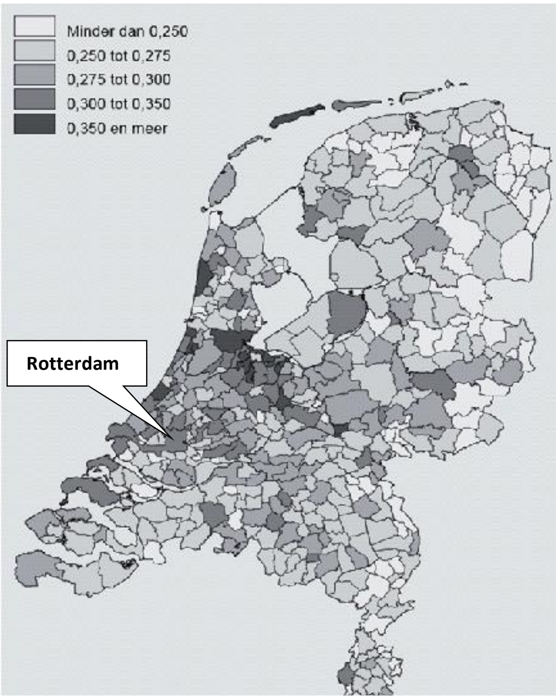
Rotterdam is the second largest city in the Netherlands, with approximately 610,000 inhabitants. It is a port city with a large industrial base. A large proportion of inhabitants are immigrants (48%). Rotterdam has poor socioeconomic indicators relative to other parts of the Netherlands: the average education level and incomes are lower than in other cities. Income inequality is relatively high and there are very high rates of poverty in Rotterdam, as shown in the maps below (GGD Rotterdam-Rijnmond, 2011).

Health indicators are relatively poor in Rotterdam: infant mortality rates are high, life expectancy is shorter and people are more likely to be obese and to perceive their health as poor than in the Netherlands as a whole (GGD Rotterdam-Rijnmond, 2011).

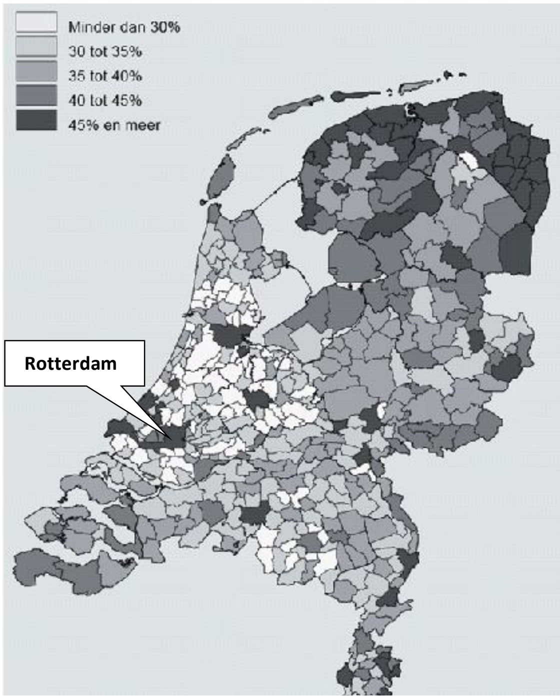
Poverty and inequality in Rotterdam and other municipalities in the Netherlands, 2008

Source: (Brakel and Ament, 2010)

a) Gini coefficient



b) Proportion of low income households (bottom 40% of households nationally)



Representation of children from all social backgrounds

The degree to which samples represent children from the whole range of social backgrounds in each country depends on a) the sampling strategy, b) the initial response rate, and c) the rate of attrition. Many of the cohorts produced weighting variables to be used in analysis to take account of these issues. However, weighting variables were not available for some cohorts and, where they were, there were some differences in the way weighting variables were calculated. It is important to identify these issues separately for each cohort and consider their effects on the findings.

- The MCS oversampled from deprived areas. Although there was some attrition, at age 5 there remained high numbers in each parental education category. Weighting variables were produced to take account of the initial sampling strategy, initial response rates and attrition, and analysis took account of sampling units. Although these cannot be perfect, we can be fairly confident that findings reflect the situation for children from different social backgrounds in the UK.
- The ECLS-K sampled from Kindergartens and schools, oversampling from private schools. The sample is therefore from relatively advantaged socioeconomic backgrounds. Although weighting variables were produced, they did not remove this bias. The effects of this can be seen in terms of the socioeconomic variables - the high incomes in this cohort reflect the sampling strategy as well as the ‘real’ situation. The sampling also affects the child health outcomes – child overweight and obesity is lower than we would expect, perhaps partly due to the sampling approach.
- The LSAC-K aimed for a nationally representative sample and produced weighting variables and sampling unit variables, so analysis could take account of sampling and attrition. We can be fairly confident that the sample reflects children from the range of social circumstances in Australia.
- The same is true of the NLSCY. However, the NLSCY used complex sampling procedures which differed for different ages and rounds of sampling. Weighting variables were produced (which seem to have the aim of analysis that represents all age groups – the effects on representation of children from different socioeconomic backgrounds is unclear). I used weighting variables in the analysis, however the effects of weighting are difficult to judge because unweighted findings were not released for inclusion in the thesis by Statistics Canada. The sampling units were neither identified in the dataset nor literature on the study, so could not be taken into account in the analysis.
- The QLSCD was a relatively small initial sample. After attrition, by age 5 there were few children from disadvantaged households in the sample. The cohort provided weighting variables to take account of the initial sample and attrition. Although I used weighting variables, estimates in the lowest socioeconomic groups were based on quite small numbers of children, so uncertainty is high. Sampling unit variables were not available, so standard errors may be underestimated (as in NLSCY).

- Gen-R recruited from all births in Rotterdam. However the sample is acknowledged to include relatively well educated parents (after exclusion of children from ethnic minority groups). This is thought to be due to the relatively low initial response rate. Attrition may have exacerbated this. Gen-R does not produce weighting variables, so analysis could not be weighted to take account of the initial sample and attrition. Therefore, it is likely to reflect the situation for a relatively advantaged group of children from Rotterdam.
- ABIS recruited from all births in South-East Sweden. This cohort also did not provide weighting variables. It is probably the case that children from the most disadvantaged backgrounds are under-represented in the analysis due to initial response and attrition and the lack of weighting variables to adjust for this.

Sample size

We should note that the sample size differed considerably. This meant that the degree of certainty for estimates is relatively low in some cohorts. In particular, this was a problem for the QLSCD (estimates in lower SEP groups were based on very small numbers of children), but it was also an issue for some parental education groups in other cohorts with small numbers of children.

Age of children

Finally, the age of children at the ‘age 5’ sweep varied between cohorts. I took account of this in the analysis by predicting outcomes from models for a child aged exactly 5 years. However, when 5 years lay on the extreme of the age distribution, this led to wide confidence intervals for the predictions (particularly the case for Generation–R).

Was it right to exclude children from ethnic minority groups?

I chose to include only children from the majority ethnic group in the sample for analysis. This was a difficult decision to make. In some ways it felt inappropriate, or ‘wrong’ to exclude a section of the population, especially as children from ethnic minority groups often suffer worse health. It also meant that the sample size was reduced considerably, especially in Gen-R and ECLS-K.

I made this decision for methodological and conceptual reasons, primarily to improve comparability (as discussed in chapter 5).

To investigate the effects of this decision, I repeated the analysis in each dataset on a ‘whole’ sample, with majority and minority ethnic groups together (and controlling for ethnicity in models). In some cases, there was little difference between the two analyses, although in others there were some differences, which varied between countries. In Gen-R, inclusion of ethnic minority children often increased inequalities, whereas the opposite was sometimes observed in the MCS. When children from ethnic minorities were included, rates of missing socioeconomic data increased.

Ideally, if I had access to data that were more comparable and thorough, e.g. with similar sampling and weighting variables in each country, and carefully and appropriately measured SEP for families from ethnic minority groups, I would have analysed all children. However, given the challenges of this comparative study, I feel that overall the decision to exclude children from ethnic minority groups has improved comparability. It helped to make the samples as similar as possible and had other methodological benefits, e.g. reducing missing data and errors associated with measurement of SEP. This is especially important, given the numerous other differences between the cohorts.

Harmonised variables

It is important to take into account differences in the way variables were measured, context, design and measurement, as well as the appropriateness of harmonisation and analysis, in order to interpret findings. These differences affect comparisons of the gradient, in terms of the slope, level and significance.

Parental education

Although I set out to create a parental education categorisation that was technically the same in each country based on qualifications/schooling level, this proved to be impossible due to differences in educational systems and educational level of the populations. I used a categorisation in the Group C cohorts (ABIS and Gen-R) that differed from the other cohorts, on a technical level (see chapter 5, Table 5-4), but was similar on a conceptual level.

One way that education status may affect health is through status and opportunity, e.g. employment options. After discussion with researchers in these countries, I believe that these different categorisations have a similar 'conceptual' meaning in terms of status and opportunities. For example, the group in the UK with no qualifications are similar to the group in Sweden with the lowest qualification (as no-one in the cohort had no qualifications) in that they are the group with the lowest status and who would likely find it difficult to obtain a job that paid above the minimum wage. Education may also affect heath through knowledge and behaviours. In this sense, it is possible that there are differences in the 'meaning' of the categories between cohorts.

Because I used absolute categories of parental education status, there were differences in the proportion of children in each parental education category. In 3 of the cohorts (ECLS-K, Gen-R and ABIS), the proportion of children in the bottom category was very small. This is important for the level/slope, as we might expect extreme outcome values in this group. This was the case in the analysis of height by parental education in ABIS, where a gradient was not apparent in the top 3 parental education categories (98% of the population), but the children from the bottom category were considerably shorter. Where there are small numbers in these bottom categories, the certainty of estimates was also affected.

Household income

Household income was measured very differently in each cohort. I chose to convert incomes to PPP$ at 2005 values for comparison. However, considerable differences remained, which made comparisons of findings difficult.

The lengths of the gradients by household income differed, making comparisons difficult. We would expect longer gradients, due to greater variation in incomes, in the most unequal countries. However, differences obtained were considerable. Much of this is likely to reflect differences in sampling and measurement. The key difference was that income was measured before tax in 4 cohorts (ECLS-K, LSAC-K, NLSCY, QLSCD), but after tax in 2 (MCS and Gen-R). If incomes had been measured after tax, we would expect them to be lower, especially at the top of the income distribution (i.e. overall mean income would be lower and the length of the gradient would be shorter). It was not possible to adjust incomes for tax, due to the complexity of tax regimes (e.g. income was from a number of sources, which may be taxed at different rates, and may include salaries one or more individuals – but this level of detail on incomes was not available in the datasets). The sampling strategy is also reflected in the distribution of incomes (the gradient is long and incomes are high in the ECLS-K, reflecting the oversampling from private schools). The way that income data were banded also plays a role. Where the top income band included many households, the top of the income distribution was effectively cut off. This meant that the length of the gradient was shortened and mean income was reduced. Although interval regression helped to spread out incomes in the top category, it did not fully compensate for this. This was the case, in particular, for Gen-R and QLSCD.

The challenges of underreporting of self-reported income due to sensitivity and complexity of incomes are widely recognised (discussed in chapter 3) (Moore et al., 2000). It is therefore likely that income data are underestimates of 'real' household incomes.

To determine the extent of these measurement problems, it is useful to compare with an external source of data on household incomes. I have compared mean equivalised income in each cohort with data from the OECD (also in PPP$, equivalised using square root of household size, data on households with children) (Table 8-1). From this comparison we can see that incomes in the ECLS-K and NLSCY are high, reflecting that measurement was before tax deductions and that income data were continuous (so the top of the distribution was not cut off in a top income band), and, in the ECLS-K, sampling more advantaged children. In the MCS and Gen-R, in comparison, incomes reported in the cohort studies were lower than OECD figures.

Table 8-1: Comparison my estimates and OECD estimates of equivalised incomes for households with children (PPP$, 2005)

	UK (MCS)	**US (ECLS-K)**	**Australia (LSAC-K)**	**Canada (NLSCY)**	**Canada (QLSCD)**	**Sweden (ABIS)**	**Netherlands (Gen-R)**
Cohort samples	20,609 (net)	33,722 (gross)	21,674 (net)	28,700 (gross)	25,097 (gross)	-	23,449 (net)
OECD national figures	22,697	29,197	20,813	25,606		19,917	25,041

Source: OECD statistics

Both sets of figures used the square root equivalisation scale. The cohort sample figures are for households with children aged 4-6 years; the OECD figures are for households with children aged 0-17 years.

Income data in my analysis were collected using cohort studies between 1999-2006 and converted to PPP$, 2005; the OECD analysis used data collected in household panel surveys 2003-2005, converted to PPP$, 2005.

I chose to equivalise household income using the square root of household size. This method does not take the number of adults and children into account, however it was not possible to use the modified OECD scale as the exact ages of children were not available in each cohort. In order to explore the effects of this on the findings, I conducted a comparison of analysis using the square root and modified OECD scales in the MCS. The findings from these analyses were very similar.

By using absolute income figures in the analysis, we should be able to compare households with exactly the same income in absolute terms. We can also compare them in relative terms – with people at the same point on the income distribution (relative to others in their cohort). I felt that reporting incomes as absolute amounts (rather than quintiles or standardised units) was the most ‘honest’ approach. We could see how income estimates varied between countries, reflecting both real differences and measurement differences. Quintiles or standardised units can hide these differences – it would be tempting to compare quintiles or standardised units as having the same meaning in each country, without acknowledging these measurement differences. However, I had not anticipated such great variation in the lengths of income gradients – making comparisons very difficult. In hindsight, it would have been useful to repeat the analysis using quintiles. This would have facilitated comparisons, in particular between cohorts that measured income before and after tax. However, there would still be problems with this approach. For example, the bottom cohort in Gen-R (which has had high attrition and did not have weighting variables) would not realistically represent the bottom 20% in Rotterdam – this would need to be taken account of in analysis. There is no perfect way to compare incomes across samples with differences in samples and measurement.

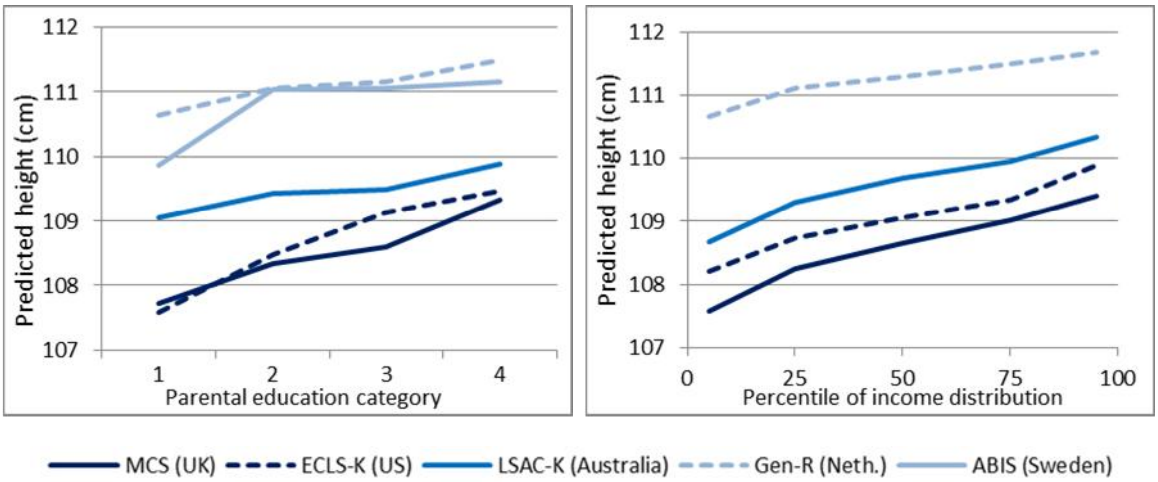
Height

For child height, I found that the gradient in height was shallower and children were taller in more equal countries. This result is unlikely to be greatly affected by the differences in measurement of height. Height was the most comparable outcome - it was measured by the interviewer in all cohorts used, except for ECLS-K, where it was reported by parents. Parental report may lead to some reporting bias, but differences between measurement and report have previously been shown to be small (Scholtens et al., 2007).

As we can compare the slope and level, I have compiled graphs showing the predicted social gradients from models in all cohorts to facilitate comparisons. The graphs show findings for girls aged exactly 5 years only, living in the same circumstances in each cohort (in a 2 parent, 2 child household in the income graph). For the income gradients, I have presented the points of the income distribution on the x axis (rather than the absolute income figures) to facilitate comparisons. We should note that graphs do not show confidence intervals, which are wide in some places, or the size of education groups. E.g. the bottom education group in Sweden is very small and has wide confidence intervals.

Figure 8-1: Summary of social gradients in height, girls aged 5, by cohort (predicted from models)

a) By parental education category b) By household income (2 parent, 2 child family)



Previous studies have also shown socioeconomic gradients in height among school age children in high income countries, e.g. (Howe et al., 2010), although there is some evidence that inequalities are reducing over time (Li and Power, 2004). It is difficult to determine the role of income inequality in differences in height. Both genetics and the social/economic environment play a role in height - it is difficult to know what proportion of differences between populations from different countries is due to environmental differences.

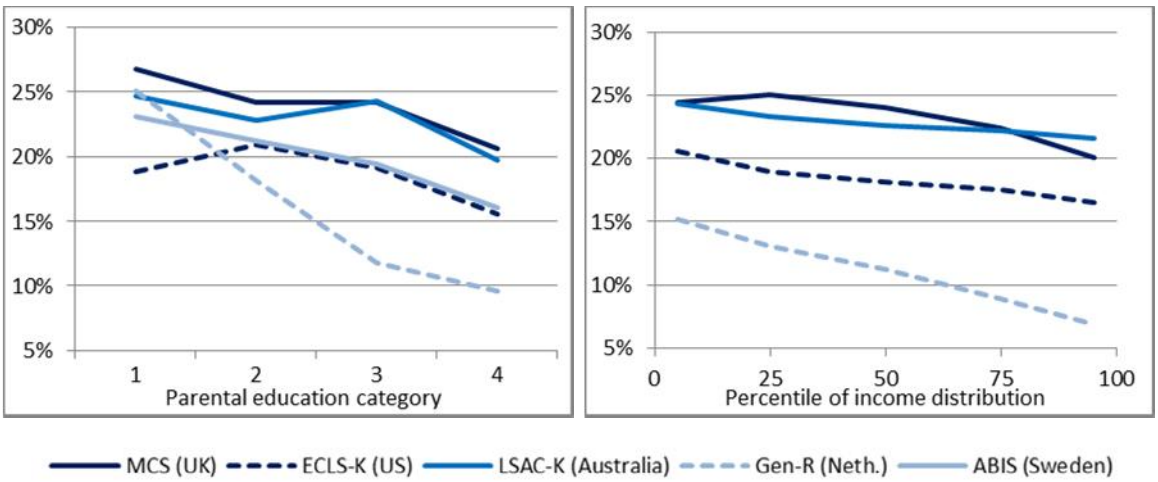
We can compare Figure 8-1 with the models of the relationship between income inequality and the social gradient developed in chapter 4. The social gradients in height correspond to model 2b (Benefit with interaction – greater equality benefits everyone; people with low SEP benefit more than people with high SEP).

Overweight and obesity

The overall level of overweight/obesity seemed to have some relationship with the level of income inequality (except in the ECLS-K, which had a lower than expected level of overweight/obesity). However, the comparisons of the slope were more complex. The gradient was evident in all cohorts, but shallowest in LSAC-K (Group B) and steepest in Gen-R (Group C). For example, analysis using multivariable models showed that girls aged exactly 5 from households at the 95th equivalised income percentile had levels of obesity 4 percentile points higher than girls at the 5th equivalised income percentile in the MCS and ECLS (Group A). By comparison, this gap was 3 percentile points in LSAC-K and 8 percentile points in Gen-R. Graphs compiling social gradients in overweight/obesity among girls age 5 from model predictions are shown in Figure 8-2.

Figure 8-2: Summary of social gradients in overweight/obesity, girls aged 5, by cohort (proportion overweight or obese predicted from models)

a) By parental education category b) By household income (2 parent, 2 child family)



There were some differences in how height and weight (used to compute BMI) were measured between cohorts, with parental report in the ECLS-K and direct measurement in all other cohorts. The use of parental report may bias comparisons – a study in the Netherlands found that parental report considerably underestimated child overweight and obesity, compared to measured data (Scholtens et al., 2007). More importantly, differences in sampling and timing of data collection are likely to have affected findings. Due to the sharp rise in prevalence of child overweight and obesity in recent years, cohorts that collected data at later dates are likely to have higher levels of overweight and obesity.

The ECKS-K had a surprisingly low level of overweight and obesity (18% overall). This may be an underestimate due to parental report. This figure also reflects the fact that data collection occurred earliest, in 1999, in this cohort. The prevalence of overweight has risen very steeply in the US since this time (Ogden et al., 2010). It may also reflect the fact that the ECLS-K oversampled from private schools, as children from more advantaged socioeconomic circumstances are less likely to have a high BMI.

Given concerns about measurement differences, it would be useful to compare my findings with an external data source collected at the same point in time, using the same methods. There is a lack of comparable international data on children – different countries and studies have used a range of different standards for defining overweight and obesity (Wang and Lobstein, 2006). The HBSC study has collected comparable data on adolescents (self-reported, so there may be some under/over-reporting problems). Overweight levels tend to be higher among adolescents than 4-6 year olds, and there are differences in samples, but it is still useful to compare the patterns between countries. From this comparison, we can see that the pattern differs considerably, with overweight levels by far the highest in the US and lowest in the Netherlands and Sweden. This supports my concern that measurement error and timing were significant biases in my study.

Table 8-2: Comparison of cohort overweight/obesity prevalence with HBSC data

	US (ECLS-K)	**UK (MCS)**	**Australia (LSAC-K)**	**Canada (NLSCY, QLSCD)**	**Netherlands (Gen-R)**	**Sweden (ABIS)**
Cohort samples (age 4-6)						
Girls:	19%	23%	23%		15%	19%
Boys:	17%	19%	18%	-	10%	15%
HBSC figures (age 11)		(England)				
Girls:	25%	10%		21%	7%	8%
Boys:	33%	13%	-	24%	5%	9%

HBSC figures are for 11 year olds, using representative national samples, 2005-6. Height and weight were self-reported.
Cohort figures are for age 4-6 year-olds, excluding twins and children from ethnic minority groups, data from 1999-2010.
Source: (Currie et al., 2008a)

There was some evidence that overweight levels were related to income inequality in the cohort analysis (although there were problems with comparability of the level of overweight). Previous studies have found that the overall level of overweight/obesity is related to income inequality among children and adults in high income countries (Pickett and Wilkinson, 2007, Pickett et al., 2005, Kim et al., 2008, Due et al., 2009b).

The gradient did not seem to be related to income inequality: there were steep gradients in overweight/obesity in all cohorts, by both measures of socioeconomic circumstances. Previous studies have found that socioeconomic inequalities in child overweight and obesity are fairly consistently present in high income countries (Knai et al., 2012). There is some evidence that inequalities in child overweight are widening over time (Knai et al., 2012). The different timing of measurement in the cohort studies may therefore have affected the slope of the gradient (i.e. it may be less steep in the earliest study – ECLS-K and more steep in the latest study – Gen-R than we would find if data had been collected at the same time).

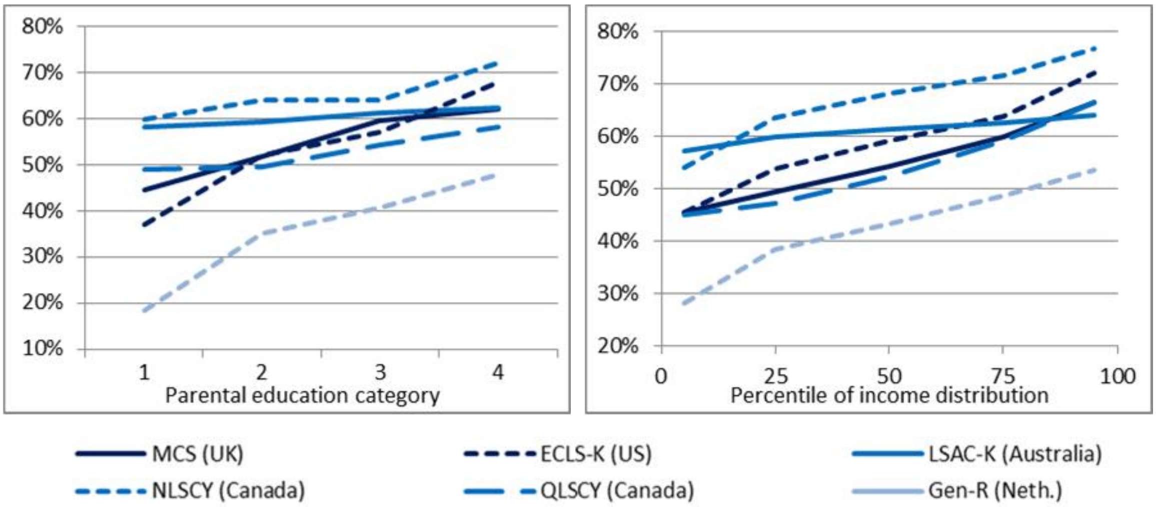
We can compare Figure 8-2 with the models of the relationship between income inequality and the social gradient developed in chapter 4. After taking into account differences in timing and measurement (especially for ECLS-K), there is some evidence that the social gradients in overweight/obesity correspond to model 2a (Benefit – the overall level of health is better in the more equal country, no interaction).

Excellent health

The pattern for excellent health in relation to income inequality was mixed. Gradients were very steep in the most unequal (Group A) countries and often less steep in Group B countries. However, Gen-R (Group C) does not fit this pattern, showing a very steep gradient. The level of parent-reported excellent health had a similar pattern - excellent health levels seemed to be higher in Group B than Group A, but they were lowest in the cohort from the most equal country (Gen-R).

Figure 8-3: Summary of social gradients in excellent health, girls aged 5, by cohort (proportion with excellent health predicted from models)

a) By parental education category b) By household income (2 parent, 2 child family)



How much did measurement approaches affect these findings? Parents were asked about their child's general health status in almost exactly the same way in each cohort. However, they may not have answered in the same way. This physical health outcome was the most subjective – parents were asked to rate their child's overall level of health. The way that people respond to subjective questions about health or wellbeing may vary between countries due to cultural differences. The level of income inequality may shape the way people respond, for example people in more equal countries with less status competition may be less likely to rate their health at the top of the scale (excellent) (Barford et al., 2010). It is also unclear what frame of reference people use to judge their children's health (e.g. relative to other children in the country/province).

The data from Gen-R seem unusual. Other studies have shown that children from the Netherlands are relatively healthy compared to children from other high income countries, for example in the international HBSC survey, adolescents in the Netherlands fared well relative to adolescents from other countries in terms of multiple health complaints (using a checklist of somatic and psychological symptoms) (3rd out of 41 countries) (but less well in their reporting of subjective fair/poor general health - 21st out of 41 countries) (Currie et al., 2008a). We need to bear in mind that Gen-R is from Rotterdam, a city with considerably worse objective and self-perceived health than other parts of the Netherlands. It is possible that parents in Gen-R rated their children's health relative to children in the rest of the Netherlands, which could explain why they rated their children's health so low.

The steep gradient in Gen-R also does not fit the patterns in the other countries (where gradients were often shallower in Group B than Group A countries). This steep gradient in Gen-R is seen for all outcomes. It may be related to the sampling from Rotterdam city in Gen-R, or may reflect real differences in the Netherlands.

I would have liked to also explore gradients in fair/poor health. I conducted preliminary analysis, but found that the numbers of children in this category were low, so confidence intervals were very wide. I therefore reported only excellent health.

Previous literature has also shown inconsistent findings for self-reported health, which may reflect differences in the way that people answer questions in relation to culture, inequality or social status (Barford et al., 2010). In a meta-analysis of previous studies, Kondo and colleagues found that the odds of reporting poor self-rated health were higher in more unequal countries (Kondo et al., 2009). However, a recent study using the World Values Study found that adult self-rated health was not related to income inequality (Jen et al., 2009).

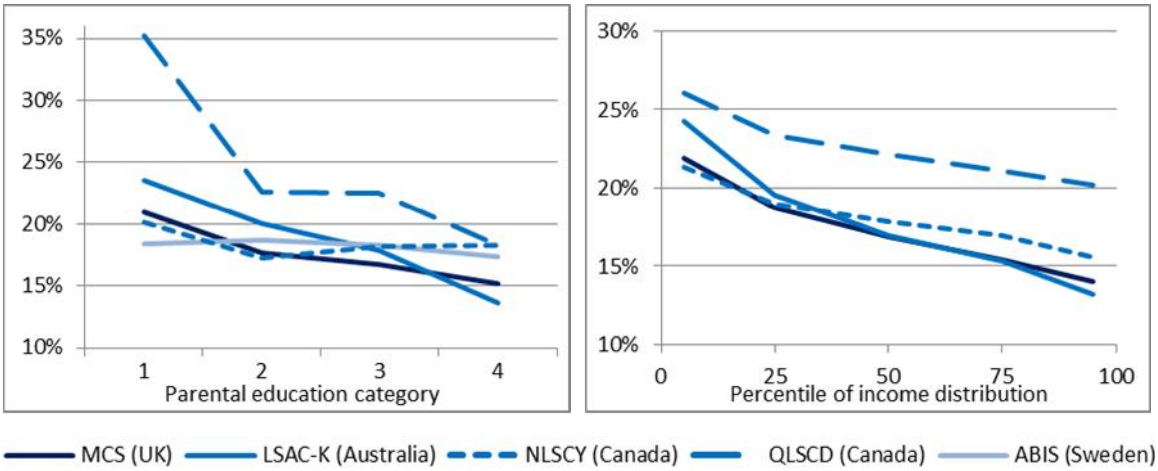
We can compare Figure 8-3 with the models of the relationship between income inequality and the social gradient developed in chapter 4. After taking the concerns about data from Generation-R into account, there is some evidence for model 2 (Benefit – the overall level of health is better in more equal countries). However, there are some inconsistencies. There are also inconsistencies with the slope, so it is not clear whether there is equal benefit or an interaction.

Chronic illness

For chronic illnesses, there were some differences in gradients that seemed to relate to levels of income inequality. Gradients were clear and consistent in the Group A cohort. In Group B, gradients were also steep and consistent in LSAC-K, but less consistent in the two Canadian cohorts. No gradient by parental education was evident in ABIS.

Figure 8-4: Summary of social gradients in chronic illness, girls aged 5, by cohort (proportion with chronic illness predicted from models)

a) By parental education category b) By household income (2 parent, 2 child family)



Chronic illness was measured slightly differently in each cohort. The questions asked parents if children had any conditions – specifying conditions over a long time period in the MCS, LSAC-K, QLSCD and NLSCY; in ABIS no time period was specified. It is therefore likely that the children with 'chronic conditions' in ABIS included some who had had short-term, acute illnesses, so may be an overestimate. In the two Canadian cohorts, the question was preceded with a list of chronic conditions (which may have prompted parents to think of conditions) (but in the MCS and LSAC-K the list followed a question about chronic conditions in general) – so chronic conditions may be underreported in the MCS and LSAC-K. There were also differences in the conditions included in the lists. Given these differences in measurement, it is difficult to compare the level of chronic illness between cohorts.

We can compare Figure 8-4 with the models of the relationship between income inequality and the social gradient developed in chapter 4. There are measurement differences for chronic illness, which make it difficult to compare. There is some evidence for model 3 (Detriment – the overall level of health is worse in the more equal countries). However, there are considerable measurement differences for chronic illness, which make it difficult to compare.

Emotional problems and anxiety and hyperactivity and inattention

Steep gradients in both emotional problems/anxiety and hyperactivity/inattention were observed in all the cohorts included for this outcome, although there was some suggestion that gradients were steepest in the Group A cohorts. Standardisation meant that we were not able to compare the level of the gradient. I have not presented summary graphs here, because we cannot compare the level. Therefore we cannot assign a model to the comparisons of the gradient.

There were considerable measurement differences for both behavioural outcomes (described in chapter 5 and tables 5-7 and 5-8). Although I attempted to improve comparability by standardising in all datasets, and dropping some items from the Canadian cohorts, considerable differences remained. Furthermore, there may be differences in the way parents responded to questions in the different cohorts due to cultural norms (e.g. hyperactivity may be more socially acceptable in some countries than others). Differences were evident in the distribution of emotional problems and anxiety scores (see section 6.5), suggesting measurement differences. There are therefore considerable concerns about comparability between cohorts.

Verbal cognition

Verbal cognition could only be compared in 3 cohorts. In these, the slope of the gradient did seem to be related to the level of income inequality when it was presented in months of development, with the greatest inequalities in cognition in the MCS.

Verbal cognition was measured using different tools in the three countries (BAS in the MCS, PPVT in the NLSCY and LSAC-K), however all tools measured a similar concept of word recognition using picture and word matching. Previous studies have compared findings from these slightly different tools, e.g. (Bradbury et al., 2010). Scores were standardised around mean=0, sd=1 for comparisons, therefore the level of the gradient could not be compared. I have not presented summary graphs here, because we cannot compare the level. Therefore we cannot assign a model to the comparisons of the gradient.

Previous studies have found that there is a relationship between income inequality and the level of cognitive development, using international PISA data, e.g. (OECD, 2010, Pickett and Wilkinson, 2007). One of these studies also compared the level and slope of the social gradient in cognition, indicating that cognitive outcomes tended to be better and the slope tended to be shallower in more equal countries (OECD, 2010). My cohort comparison reinforces these previous findings.

Further analytical considerations

Many of the key issues related to analysis have been discussed in the discussion above. Some other important factors need to be noted.

At the start of the analysis I made the decision not to impute data, as weighting variables could be used to take account of attrition, and item non-response seemed to be low in the first cohorts that I analysed. However, when I analysed Gen-R and ABIS (these were the last two cohorts I gained access to), I found that weighting variables were not available and missing data rates were high in Gen-R. Item non-response and attrition tended to disproportionately affect children in less socioeconomically advantaged groups, so estimates are likely to be biased as a result of this. In hindsight, imputation across all the cohorts could have improved estimates, especially for Gen-R and ABIS. However, this would also have greatly increased the burden of data management across all 7 cohorts.

Many researchers have noted the importance of testing the goodness of fit for models with assumptions about relationships, e.g. (Frank and Haw, 2011). However, I was not able to check goodness of fit for my models. This is because the diagnostic and post-estimation tests cannot be used with models using weighted data in STATA. This is particularly concerning, as survey weighting can lead to some points having high influence or leverage (even if they are not normally considered outliers), but it was not possible to check for this.

8.3. Explanations of differences

Having considered whether the extent to which findings represent 'real' population differences, it is now useful to consider the causes of these differences. Do differences in income inequality between the countries explain the differences between social gradients in child health and development?

Income inequality in the study countries

My findings provide some evidence for a relationship between income inequality and social gradient in child health and development. The study has not tested for a causal relationship. However, this study does add to the body of evidence on the relationship between income inequality and social gradients that was outlined in the critical review (chapter 4). The overall evidence for a causal relationship is discussed further in chapter 9.

In order to consider the role that income inequality plays, it is useful to consider income inequality in the study countries and possible causal mechanisms. It is also useful to consider alternate explanations for the comparative findings, e.g. other economic or policy differences.

Patterns of income inequality

I analysed income inequality, as a proxy for social stratification, using the Gini coefficient, measured after taxes and transfers in each country (to reflect differences in disposable household income). As discussed in chapter 3, there are numerous approaches to measuring income inequality. The Gini coefficient is widely used, but has drawbacks, including that it particularly reflects the middle part of the income distribution. However, other measures showed a similar pattern of income inequality between the study countries, e.g. the 90/10 decile share ratio (Table 8-3).

As noted earlier in this chapter, some of the cohorts sampled from cities or regions, rather than countries. I applied the country-level Gini coefficient to these cohorts, but we should bear in mind that levels of income inequality in the cities or regions may also be important for people’s health and wellbeing.

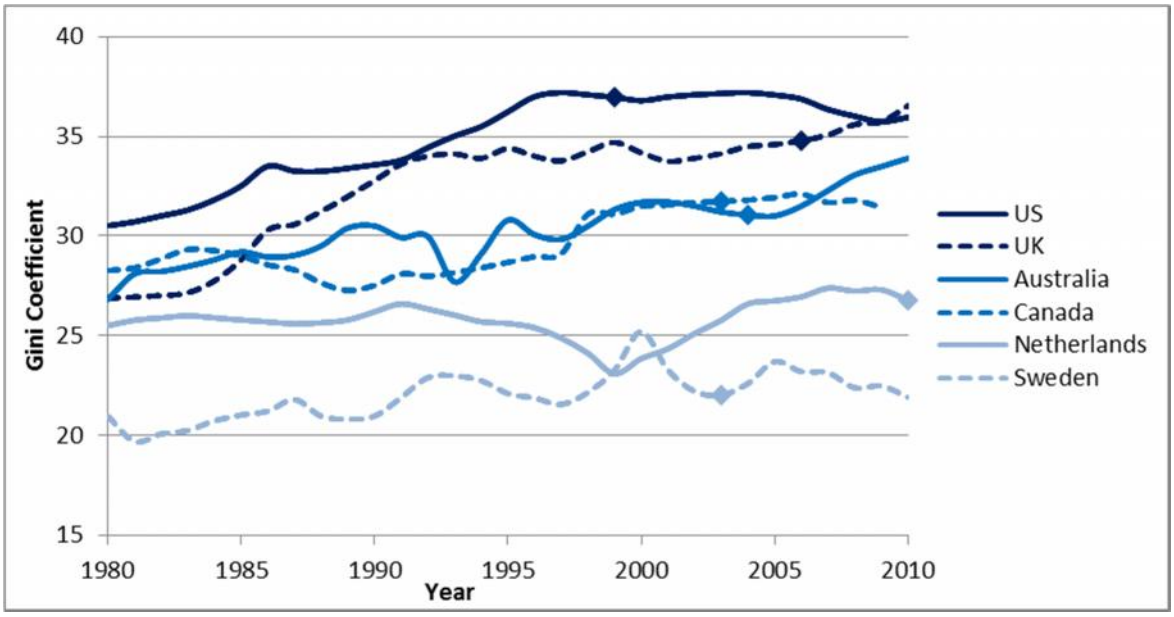
Mechanisms and time lags

Income inequality may affect child health through a number of pathways, including macro-level differences in policy and services, community-level differences in social capital and individual level factors (which are shaped by higher level factors), such as stress. It is likely that changes in income inequality may take some time to ‘filter through’ to affect changes in children’s health and development. The effects of these changes may also take place across the lifecourse, e.g. exposures in utero may affect the health and development outcomes I have compared at age 5 (reviewed in chapter 2).

These time lags are likely to vary between outcomes. Height, for example, may have a long lag due to the importance of lifecourse influences across generations. Inequalities in child height are influenced by factors such a parental smoking, nutrition and stress, and particularly by parental height - which, in turn, reflects both genetics and social/environmental conditions when they were in utero and growing up (Galobardes et al., 2012). Thus, the social environment may have effects on height several decades later. Overweight/obesity and the behavioural outcomes, on the other hand, may have a shorter lag time.

Given this, it is interesting to look at how income inequality has changed over time in the study countries. Income inequality has risen sharply in the Group A countries (US and UK) and the Group B countries (Australia and Canada). Although there has been some rise in income inequality in Group C countries (the Netherlands and Sweden), the rise has been more modest.

Figure 8-5: Changes in income inequality over time in the study countries, 1980-2010



Note: markers show the time point at which the data I used in my analysis were collected

Source: SWIID data

National income

To what extent can differences between the cohorts be explained in terms of economic differences? First, it is worth noting that the study countries all lie towards the middle of the distribution of OECD countries, in terms of Gross National Income per capita (as shown for the year 2005 in Figure 8-6). Some countries were chosen to represent extremes of income inequality, but none represent extremes of Gross National Income.

Previous studies have shown that average levels of health and wellbeing in countries have little relationship to the ***national*** level of wealth (Wilkinson and Pickett, 2009b). In my analysis, no clear relationship between national level wealth (GNI per capita) and the social gradients in child health and development in the study countries was apparent. For example, figures in Table 8-3 show that the two wealthiest countries are the US and Sweden – yet the analysis of data from the US showed consistently steep slopes, whereas slopes were often shallowest and least consistent in the data from Sweden.

However, ***within countries*** the level of wealth or deprivation of the area that people live in is an important influence on health and development. This pattern is observed for many health outcomes, for example infant mortality rates are considerably higher in the more deprived areas of the UK (Norman et al., 2008). This is an important consideration for the interpretation of the cohorts that sampled at a sub-national level, in particular Gen-R, because Rotterdam is home to people with lower incomes relative to other areas of the Netherlands (Brakel and Ament, 2010). It is therefore likely that overall levels of health and development are poorer in the Gen-R sample than they would be in the Netherlands as a whole.

Table 8-3: Economic and policy context in the study countries

	Group A		Group B		Group C	
	US	**UK**	**Australia**	**Canada**	**Nether-lands**	**Sweden**
Economic context						
GNI per capita, US$, 2005	44,630	38,880	30,410	33,110	39,880	42,950
Inequality and poverty						
Gini (market) *****	47.1	47.8	42.9	43.3	46.1	43.1
Gini (net-after taxes and transfers) *****	37.0	34.8	31.1	31.7	26.8	22.2
% reduction in Gini due to taxes and transfers*****	21%	27%	28%	27%	42%	48%
90/10 decile share ratio **	12.7	9.7	7.7	8.5	7.1	5.0
Child poverty rate***	20.6%	10.1%	11.8%	15.1%	11.5%	4.0%
Health and child policies						
Total health expenditure, % GDP, 2005	15.2%	7.9%	8.0%	9.3%	10.1%	8.7%
Total expenditure on child care and pre-school education, % GDP, 2005	0.3	0.8	0.4	0.2	0.5	1.1
Maximum length of maternity leave for women (maternity + parental leave), weeks, 2011-12	12	65	52	52	42	70
Of which receiving full salary	0	13	3	28	21	47

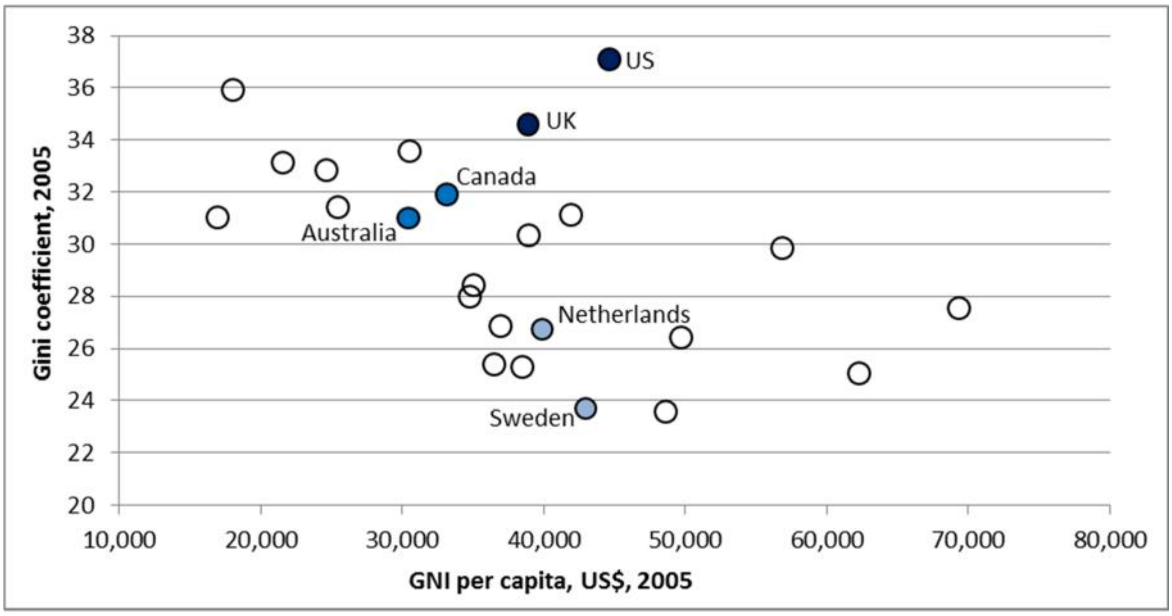
Source: GNI, 90/10 ratio, child poverty, health and child policies: OECD statistics. Gini coefficients: SWIID version 3

*Data for study years – US (1999), UK (2006), Australia (2004), Canada (2003), Netherlands (2007), Sweden (2003)

** Data for study years, except US (2000) and Sweden (2000)

*** The child poverty measure used is the proportion of households with children living on an equivalised income below 50% of the national median income for the year 2005. Children are defined as those aged 0-17 years.

Figure 8-6: Gross National Income and income inequality in study countries and other OECD countries, 2005



Source: GNI per capita from OECD statistics; Gini coefficient from SWIID

Poverty

To what extent are differences in the social gradient in health and development due to poverty, rather than inequality across the whole of society?

As discussed in chapter 2, some have suggested that the relationship between income inequality and health could be explained by the proportion of people in poverty – i.e. if there are a lot of people living in poverty in a country who have poor health, this could pull down the average level of health for the population as a whole. However, studies employing multilevel modelling have shown that the proportion living in poverty does not fully explain the relationship, e.g. (Mayer and Sarin, 2005)

First, we should note that poverty and inequality are closely related. Relative poverty – the proportion of people who live below a cut-off set relative to the rest of the population (e.g. 50% median income) – reflects the level of inequality in society, with a focus on the bottom of the hierarchy. Child poverty rates in the study countries are shown in Table 8-3. There is some relationship with the level of income inequality – rates are highest in the US and lowest in Sweden, though the child poverty rate is relatively high in Canada.

My findings allow us to compare health and development outcomes across socioeconomic groups between the countries, showing that health and development have generally have a finely graded relationship with socioeconomic circumstances, especially in more unequal countries. Many of my analyses showed that each step down the social ladder brings further health and development disadvantage, in line with previous studies (e.g. summarised in (Marmot, 2010). For example, relative to those in the top education and income categories in each country, parents in lower socioeconomic groups were less and less likely to report that their children had excellent general health. We generally do not see a dichotomy between health and development of the poor and non-poor. For some cohorts and outcomes there was some evidence that children in the most disadvantaged group did considerably worse (e.g. for emotional problems/anxiety) – but this was not a common pattern.

Where it was possible to compare the level of health in a valid way, we saw that children do better at each point in the social hierarchy in the more equal countries. This was true for height. There was some evidence of this pattern for excellent health, excluding findings from Gen-R. This pattern has also been shown in several previous studies, reviewed in chapter 4. However, these findings were variable and there was also contradictory evidence.

In order to test the role of poverty and income inequality, we would need to develop multilevel models with comparable data on child health and development from a larger number of study countries.

In summary, child poverty is, of course, an important cause of poor health and development in the study countries, and is related to income inequality. However, it does not, alone, seem to explain the differences in the level and slope of the gradients shown. There is some preliminary evidence of differences in health and development across all points of the social hierarchy, not just due to differences in the number of children living in poverty and their health and development.

Welfare policies

To what extent do these differences in welfare policies, including social transfers and services provided, explain the differences in the social gradient in child health/development? Is income inequality a proxy for the type of welfare regime?

According to Esping-Andersen's classification of welfare regimes, both Group A countries (US and UK) and both Group B countries (Australia and Canada) fit into the liberal type of regime; both Group C countries (Netherlands and Sweden) fit into the Social Democratic regime type. None of the study countries have a Conservative regime. As discussed in chapter 2, the type of welfare regime affects the level of social stratification, through services and social transfers. There is a clear relationship between welfare regimes and income inequality in OECD countries (Figure 8-7).

Differences in welfare regimes, in terms of service provision and social transfer policies between the study countries, may also influence population health and health inequalities (Eikemo et al., 2008a) (Eikemo et al., 2008b). They may also provide a ‘buffer’ to the effects of income inequality on health.

First, we can consider social transfers. Social transfers are most extensive in the Group C countries (see Table 8-3). This has a redistributive effect, reducing income inequality. Market income inequality is high in Sweden and the Netherlands (before taxes and transfers), but reduced by almost 50% through taxation and transfers. In the US, in contrast, where taxes and transfers are lowest, they reduce the Gini coefficient by just over 20%.

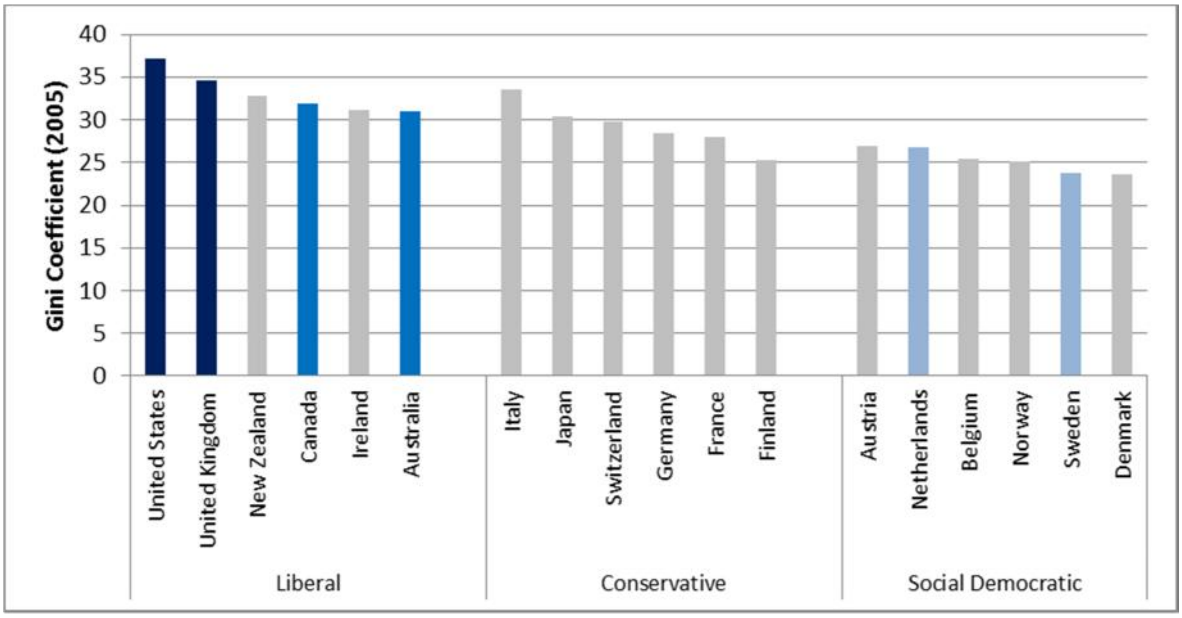
Some social transfers may also have a more direct effect on health. For example, paid parental leave allows parents to spend time caring for their infants and breastfeed - and is associated with lower infant and child mortality rates (Heymann et al., 2010). Maternity leave policies are most generous in Sweden, where women can take up to 70 weeks of leave, of which 47 are fully paid. Paid maternity leave is also quite generous in Canada and the Netherlands. They are least generous in the US, with only 12 weeks of leave, and no right to any fully paid weeks of leave (Table 8-3).

We also need to consider services, or ‘benefits in kind’. There are considerable differences between the study countries in terms of health systems and other child and social policies. National health spending is by far highest in the US, at over 15% of GDP. In the other study countries health expenditure is around 8-10% (Table 8-3). Health expenditure alone, therefore, clearly does not explain the patterns that we see between the study countries.

Early child care and preschool education services are also important for child health and development. Total expenditure on child care and pre-school education varies considerably between the study countries, and bears little relationship to income inequality or social gradients. Expenditure is lowest in Canada, and highest in Sweden (Table 8-3).

Measures of income inequality using household income do not take account of the value of ‘benefits in kind’. These benefits in kind are redistributive and may make an important difference to living standards between the countries.

Figure 8-7: Welfare regimes in the study countries and other OECD countries, in relation to income inequality



Source: Gini coefficients from SWIID

In summary, classifications of welfare systems are crude and there are big differences between countries within each regime, e.g. between policies in the US and Canada. The welfare regime alone does not explain the differences in social gradients between the study countries. Specific policies such as provision of child care and maternity leave are likely to shape the social gradient in child health/development, although these associations have not been tested in this thesis.

Welfare policies are closely linked to levels of income inequality. Social transfers and services affect levels of income inequality in society; income inequality may shape health partly through differences in services provided and services provision could buffer the psychosocial effects of living in an unequal society. It is therefore difficult to separate the effects of welfare policies from levels of income inequality. Given these links, it is useful to useful to consider the welfare state in discussion of policy responses to income inequality (discussed in chapter 9).

Other differences

There are certainly cultural differences between the study countries. The role of these differences is difficult to study, as it can be hard to define cultural differences and summarise them quantitatively. Sweden, for example is sometimes thought to have a particularly collectivist culture (Saunders, 2010). Culture is likely to be closely linked to income inequality – both as a cause and consequence of patterns of social differentiation (Rowlingson, 2011). Some authors have also suggested that the relationship between income inequality and heath can be explained by ethnicity (Saunders, 2010). This is not a concern in the comparative cohort analysis, as children from minority ethnic groups have not been included in the analysis.

8.4. Summary of limitations

This chapter has summarised the issues that affected the validity of findings and their subsequent interpretation. These issues were limitations to the study – although I minimised them where possible, a number of differences remained that needed to be taken into account in interpretation. As discussed above, the following issues were key limitations:

- Differences in sampling approaches between datasets. Many of these differences were minimised during harmonisation, but a number of key differences remained. In particular, Gen-R had a number of differences from other cohorts, which may have affected findings on the social gradient.
- Attrition and item non-response. Weighting variables were used to adjust for attrition in the MCS, NLSCY and QLSCD (although these are not perfect and estimates in some low socioeconomic groups were based on small numbers due to attrition). Weighting variables were not available in Gen-R and ABIS, so it is likely that samples under-represented children from more disadvantaged backgrounds. I chose not to impute data due to low levels of item non-response, however this was a bigger problem in Gen-R.
- It was difficult to define socioeconomic position in a comparable way between countries. Parental education categories have a similar conceptual meaning, but some differences remain between categories. Income data were collected in different ways in each cohort, and the distribution of household incomes varied considerably. Sampling approaches affect out interpretation of these variables.
- Child health and development outcomes were collected in different ways between cohorts. Although they were harmonised as far as possible, some differences remain. Where outcomes were standardised to improve comparability, it was not possible to compare the level of the gradient.
- It was not possible to assess whether the relationship between income inequality and social gradients in health is causal with the data available (cross-sectional, few countries, methodological differences between cohorts).
- It is difficult to ascertain the importance of income inequality in explaining the differences in social gradients in child health and inequality, in relation to other, related factors such as welfare policies.

It would have been useful to combine the datasets and (with extra countries, if possible) use multilevel modelling strategies to analyse the relationship between income inequality, SEP and health. However, this was not possible due to logistical issues – several datasets could only be analysed in in situ in the cohort country and could not be merged with other datasets. As datasets were analysed separately, I was not able to control for confounding factors at the societal level. I therefore included discussion of country-level differences in this chapter.

Despite all these differences, careful harmonisation and taking differences into account in analysis and interpretation of findings allowed us to make some useful comparisons between datasets.

This study has also highlighted the lack of comparable individual-level data on child health and development. Although I was able to harmonise data from a number of different studies, this was problematic both logistically and conceptually. It also led to many limitations for the analysis and challenges with interpretation of findings. The need for more comparable data is discussed further in chapter 9.

8.5. Summary of chapter 8

This chapter discussed findings from the comparative cohort analysis.

1) There were numerous differences between the cohorts, with large implications for the validity of social gradients observed and comparisons between countries.
2) There were large differences in sampling. Four of the cohorts had national samples (MCS, ECLS-K, LSAC-K and NLSCY), but 2 had subnational samples of a region/province (QLSCD and ABIS) and 1 sampled from a city (Gen-R - Rotterdam) – these cannot be generalised to the national level. In particular, Rotterdam differs greatly from the rest of the Netherlands – it has higher inequality and poverty, lower socioeconomic indicators and poorer health. The ECLS-K oversampled from private schools, so had a relatively advantaged sample.
3) There were differences in the ways that household income and parental education were measured between cohorts, and contextual differences (e.g. differences in educational systems and 'norms'). Harmonisation minimised these differences, but could not remove them completely. Differences in the 'length' of the household income gradient (due to differences in sampling and the way household income was measured) make gradients in household income difficult to compare.
4) There were also differences in the way health and development outcomes were measured. Height was most comparable. Obesity was measured comparably, but the level of the gradient was affected by the sample and timing of measurement. There were some differences in the way that chronic diseases were measured, which may have affected the level. General health was measured in the same way in each cohort, but it is likely that parents answered differently, e.g. using different reference groups. Emotional problems/anxiety and hyperactivity/inattention, as well as verbal cognition, were measured using different tools and scales, but were standardised for comparison.
5) These differences meant that there was limited possibility to compare the level of the gradient. It was possible to compare the slope, however. Given these limitations, findings can be summarised as follows:
   - For height, the social gradient is shallower in more equal countries and the level is higher. There is clear evidence of 'fanning out' - children from all social backgrounds do better in more equal countries, with greatest benefit among more disadvantaged groups.
   - For overweight and obesity, steep social gradients were observed in all countries. The level tended to be lowest in the most equal countries (with the exception of the US, due to measurement differences) – children from all social backgrounds do better in more equal countries.

- For excellent health the pattern is mixed, but there is some indication that the gradient is shallower and level is higher in more equal countries (except for Gen-R).
- For chronic illness, there was some evidence of a relationship between the slope and income inequality, although there were some inconsistencies. There did not seem to be a relationship with the level, although there were measurement differences.
- For emotional problems/anxiety and hyperactivity/inattention, the findings are inconclusive. There is a steep gradient in all the countries (with some indication that the gradient in hyperactivity and inattention is shallower in more equal countries). But the level could not be compared and there are considerable measurement problems.
- For verbal cognition, the gradient is shallower in more equal countries but the level could not be compared.

6) Gen-R generally does not fit the patterns observed – it stands out as having steep gradients. This needs to be interpreted taking the city context into account – perhaps it should have been considered a middle inequality cohort (Group B).
7) Overall, there is some evidence of a relationship between income inequality and social gradient in child health and development.
8) Some contextual differences between the countries play an important role. Differences in the level of wealth and poverty in each country do not explain differences in the social gradient. Differences in welfare systems are related to income inequality – they are likely to play a role through influences on income inequality and through moderating and mediating effects of income inequality and SEP on health.

PART III: DISCUSSION AND CONCLUSIONS

Chapter 9: Discussion of the evidence on social gradients in child health and development in relation to income inequality

This chapter discusses the findings from the critical review and comparative cohort analysis, in the context of the background literature review chapters. I first summarise evidence from the critical review and the comparative cohort analysis. I discuss this evidence in relation to previous literature, in order to develop conceptual understanding of the relationships between income inequality, socioeconomic position and child health and development. I then discuss the evidence in relation to the policy context, drawing out implications for policy and include a discussion of the situation in the UK. I finish with a discussion of the data and methods that I employed and future research needed to improve the evidence base on social gradients in child health and development in relation to income inequality.

9.1. Introduction

This thesis has explored how the social gradient in child health and development varies in relation to income inequality in high income countries. I have used review of the literature and comparative analysis of cohort studies to answer the following overarching questions:

- How does the *slope* of the social gradient vary in relation to income inequality? (Is the gradient steeper in more unequal countries?)
- How does the *level* of the social gradient vary in relation to income inequality? (Is health worse overall in more unequal countries?)
- *Does everyone do better in more equal countries*? (comparing both the slope and level of the gradient)

In this chapter, I compile the evidence presented in the thesis in the critical review and comparative cohort analysis, in relation to these questions. I then discuss this evidence, with reference to previous literature, to build on current theory and discuss policy implications. In light of the findings that the UK is particularly unequal and has steep inequalities in child health and development, I have included a discussion of the current UK context. I finish with a discussion of data and methods that I have used and that are required in the future to understand social gradients in child health and development in relation to income inequality.

This chapter meets objective 4: *To summarise and discuss current evidence on social gradients in child health and development in relation to income inequality.*

9.2. How do social gradients in child health and development vary between more and less equal societies?

Summary of thesis findings

There was considerable variability in the findings from the critical review and comparative cohort analysis. They do not provide unequivocal proof on the relationship between income inequality and social gradients in health/development/wellbeing – but taken together they build up a picture of the evidence so far. In relation to the overarching research questions, the evidence can be summarised as follows:

1) How does the *slope* of the social gradient vary in relation to income inequality? (Is the gradient steeper in more unequal countries?)

The critical review of previous studies that have compared the social gradient in health and wellbeing (chapter 4) indicated that the slope of the gradient was either steeper in more unequal countries, or there was no clear difference in the slope. There was very little evidence of social gradients being steeper in more equal countries.

My comparative cohort analysis (chapters 5-8) produced mixed findings regarding social gradients in child health and development. Height gradients were considerably steeper in more unequal countries, as were gradients in verbal cognition. There is also some indication that gradients in excellent health and chronic illness were steeper in more unequal countries, although there was some variation and inconsistency. However, there were not clear differences in the slope for overweight/obesity and behavioural problems.

2) How does the *level* of the social gradient vary in relation to income inequality? (Is health worse overall in more unequal countries?)

In the critical review (chapter 2), nearly all previous studies comparing the social gradient in mortality and physical health (objectively measured) suggested that the level of health and wellbeing is better in more equal countries or there is no difference. The same was true for literacy and cognition. For subjectively reported health, there was more variation – some showed better health and wellbeing in more equal countries, but some showed a poorer level in more equal countries. Studies comparing social gradients in behavioural and mental health outcomes showed better behavioural outcomes in more unequal countries. In many of the previous studies, it was not possible to compare the level as scores were standardised.

My comparative cohort analysis (chapters 5-8) produced mixed findings relating to the level. Children were taller in the more equal countries. They were also less likely to be overweight/obese in more equal societies (with the exception of the US, due to measurement differences). Parents were more likely to report that their children had excellent general health in the more equal countries, except in Rotterdam. The level of chronic illnesses did not seem to be related to income inequality, but there were concerns with measurement differences. We could not compare the level for other outcomes, as scores were standardised.

3) *Does everyone do better in more equal countries*? (comparing both the slope and level of the gradient)

In the critical review of previous studies (chapter 4), the greatest support was provided for model 2b: that health and wellbeing are better in more equal countries; the gradient is steeper in more unequal countries; people with low SEP benefit the most in more equal countries. There were differences by outcome – many of the studies using mortality and more objectively measured outcomes suggested that people across society do better in more equal countries. However, findings were more varied for subjective health outcomes and for behavioural/mental health and cognitive/literacy outcomes. Some studies showed no difference between societies, and some suggested a detriment in more unequal countries. It is worth noting that no studies suggested that greater income equality is beneficial for people in low socioeconomic positions, but detrimental for people with high socioeconomic positions.

In my comparative cohort analysis, there was some evidence that children from a range of socioeconomic backgrounds do better in more equal countries, although there were differences between outcomes and inconsistencies (some of which appeared to be related to measurement differences). This finding was most clear for height – all children did better in more equal countries, and the benefits were greatest among children from disadvantaged socioeconomic backgrounds. There was some indication that children across the range of socioeconomic backgrounds were more likely to have excellent health (parent-reported) in more equal countries, but this was less marked and there were deviations from this pattern, particularly in Rotterdam. Children from all socioeconomic backgrounds were less likely to be overweight/obese in more equal countries (with the exception of the US, which could be explained by timing and measurement differences). It was not possible to assess this for behavioural and cognitive outcomes, or for chronic illness due to measurement differences affecting the level of the gradient.

Putting the picture on the slope and level together, there is some evidence that the benefits of living in a more equal country are felt across society. However this is not a consistent picture – there are many differences between studies.

Why is this important?

There are many reasons that these findings are important, of which four reasons have particular theoretical and policy importance. I discuss some of these theoretical and policy implications in further detail later in this chapter.

1) By age 5 there are already socioeconomic inequalities in child health/development, across a range of physical, socio-emotional/behavioural and cognitive outcomes

Health and development are often poorer with every step down the social ladder, in terms of parental education or household income. This was evident across many of the outcomes, with some inconsistencies. This suggests a health and development penalty early in life for children who are not in the most socioeconomically advantaged circumstances.

This compromised health and development also has long term implications into adulthood. As a recent report on early child development summarised: "The development that occurs in the early years provides the essential building blocks for a lifetime of success in many domains of life, including economic, social and physical wellbeing" (Irwin et al., 2007, page 9). Early childhood is therefore a window of opportunity for action to prevent inequalities in health and wellbeing throughout the lifecourse.

2) The observation that social gradients are shallower in some countries than others shows that such inequalities are not inevitable

For some outcomes, there was a clear difference in the extent to which children's socioeconomic position influenced their level of health and development. The steep gradients in height that we see in the UK are not seen in Sweden, for example – they could be avoided. Likewise, the steep gradient in verbal cognition by age 5 in the UK (children whose parents do not have secondary qualifications are 15 months behind children with one or more parent with a degree) was not observed in Canada (where the parental education gap was 9 months).

This has moral implications. Such differences are therefore inequitable – they are "*unnecessary and avoidable but, in addition, are also considered unfair and unjust*" (Whitehead, 1992, page 5). It also suggests that such differences could be avoided through appropriate policies and interventions.

3) The patterns of income inequality are likely to be a key factor that shapes these health inequalities

The level and slope of the gradient are frequently related to the degree of income inequality. This suggests that the degree of income inequality (in itself, or as a marker of wider social differentiation) in society is a key driver of health, together with family socioeconomic position. It therefore implies that reductions in income inequality could reduce inequalities in health.

4) The growing evidence that everyone does better in more equal countries suggests that if countries were more equal, children from all social backgrounds would benefit

In societies that are more equal, there is some evidence that children from disadvantaged backgrounds benefit a lot, but children from advantaged backgrounds would also benefit. On the other hand, there is some evidence that everyone suffers from living in an unequal society (discussed in section 9.4). This has important policy implications.

9.3. Understanding the relationships between income inequality, socioeconomic position, and health

This section discusses the findings from the thesis in relation to current literature and theory.

There are layers of influence on child health and development

Income inequality (at the societal level) and socioeconomic position (at the family/household level) have overlapping influences on child health and development. A conceptual framework summarising these layers of influence was developed in Chapter 2, Figure 2-5.

Children live within many overlapping ***contexts***, including income inequality (at the societal level) and socioeconomic position (at the family level). These influence ***child health and development*** through a number of interlinked ***pathways***, including psychosocial, material and neo-material, and behavioural pathways. These pathways may directly affect children themselves, or may affect parents and other household members, with indirect effects on children's health. Socioeconomic position and income inequality interrelate in terms of the pathways. In more equal countries, a low socioeconomic position may be less detrimental to health and development, for example due to an equitable child care services or because there is less status competition. On the other hand, children with a low socioeconomic position in an unequal country suffer a double burden (see Figure 9-1). The whole process takes place across the ***lifecourse*** - context and processes earlier in life may affect children's health and development.

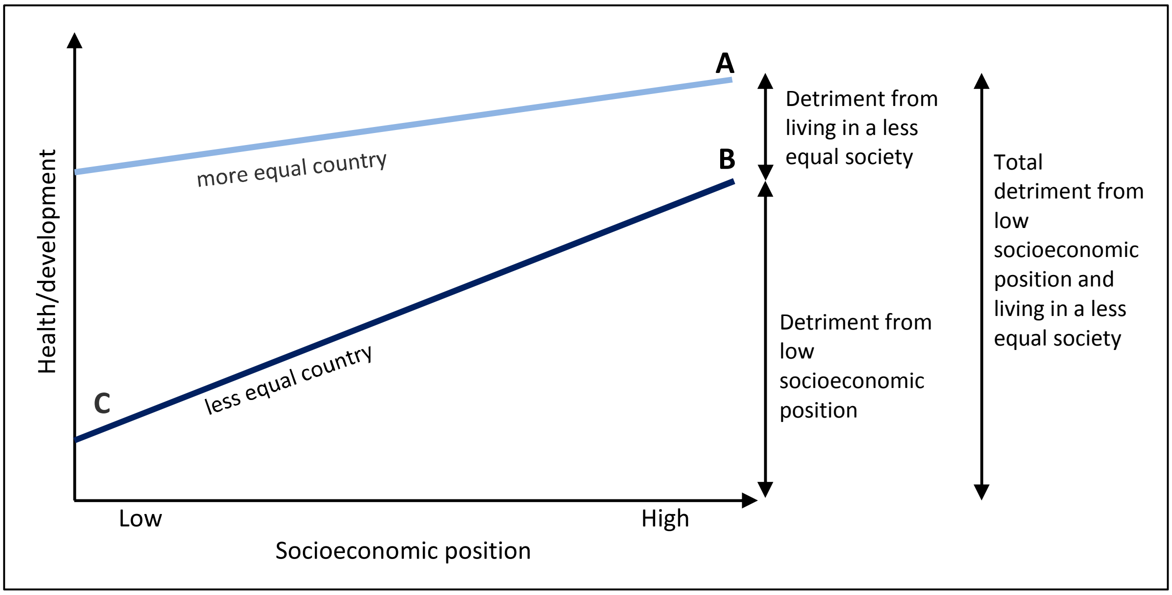
Children across society are vulnerable

Within each country, children at all points on the social hierarchy experience a detriment relative to children in the most advantaged position. Furthermore, there is growing evidence that children in less equal societies experience a detriment relative to children from more equal countries. Therefore we can think of layers of detriment, as illustrated in Figure 9-1.

Consider a child living in a less equal society, in disadvantaged socioeconomic circumstances (point C in the figure). They experience a detriment relative to a child living in advantaged socioeconomic circumstances in the same country (point B). The size of this detriment is related to the *slope* of the gradient. In the less equal society, the gap between the health they experienced and the level they could achieve is large; in the more equal society, there is a similar pattern – but the gap is smaller. They also experience a detriment relative to children in more equal countries. The size of this gradient relates to the *level* of the gradient.

Bringing these together, we can see that all children in the less equal society experience an inequality detriment. Children in less advantaged socioeconomic circumstances in unequal societies may experience a double detriment – from individual socioeconomic circumstances and from living in an unequal country. Nearly everyone across society is affected.

Figure 9-1: Layers of health and development detriment



The lived experience of growing up in an unequal country

Qualitative research is useful to understand how it feels to grow up in an unequal country, and how this could affect children's health and development. A recent study of children's experiences of growing up in the UK, Spain and Sweden used interviews with children, observations and film of families to understand how children experience the interplay between materialism, inequality and well-being (Ipsos MORI and Nairn, 2011). This report aimed to look 'behind the statistics' of child wellbeing.

Children frequently mentioned that time with people that they love, creative and sporting activities and being outdoors and having fun made them happy. The researchers found that there were differences in children's experiences of these across the study countries, and that these differences often linked with materialism and inequality.

Children's awareness of inequality grew as they reached secondary school. Children were aware of status – they felt that being perceived to be poor could lead to being bullied. For example, a child from the UK said:

> "If I was poor I wouldn't want to tell anyone in case they didn't want to hang around with me, and so other kids didn't pick on me".
>
> UK, age 8/9 (Ipsos MORI and Nairn, 2011, page 59)

In this environment, children were distinguished based on their outward appearance, including their possession of material and branded goods. In Spain and the UK, in particular, children associated branded goods with wealth and popularity. In the UK, brands and desirable clothing or technology were particularly important for children's status and to hide feelings of inadequacy. As one boy in the UK noted:

> "No matter how much money they have, people still manage to put up a front of like they have money – the way to prove it is like, say they have an iPod, even if they save their money for years [to buy it], and then instantly, they'll be accepted into whatever social circle there is… You could live in a dustbin, and as long as you have an iPod, a Blackberry, then you're accepted. Okay, it's a bit of an exaggeration but you know what I mean"
>
> UK, age 14 (Ipsos MORI and Nairn, 2011, page 62)

The ways that inequality influenced parenting were also explored. Parents in the UK were struggling to give time to their children. In Spain and Sweden, this issue was less evident – in Sweden, in particular, family time was considered an integral part of everyday life.

This qualitative study builds up a picture of how children in the UK are particularly concerned about seeming wealthy, in terms of their appearance and branded goods, and have fewer opportunities to do activities they enjoy with their families. It is clear to see how this could be stressful for children in the UK. In Sweden, these issues were not absent – children mentioned the need for social status – however, they were less prominent. Also, children had more opportunity to spend time with their family and doing non-competitive sport and creative activities.

There has been very little qualitative work exploring how people experience social inequality. Further research on this, with children and parents, could aid our understanding of inequality 'gets under the skin'.

Causality and the interpretation of the evidence on income inequality and health

In this thesis we are interested in two causal relationships: socioeconomic position and health/development, and income inequality and health/development – and the interaction between the two exposures. The studies I have reviewed and my comparative cohort analysis show some evidence that the association between socioeconomic position and health varies in relation to income inequality. However, all the studies are cross-sectional and it is not clear whether this relationship is causal. Other factors, such as chance, biases or other differences between the countries could explain the relationships observed.

The causal relationship between socioeconomic position and health outcomes is widely accepted, although there are different explanations for the relationship (summarised in chapter 2). Therefore, I focus this discussion on the role of income inequality. Although the correlation between income inequality (at national or state level) and health is now widely accepted, there is some debate about causality and mechanisms (chapter 2).

In chapter 8, I discussed the role of other differences between the study countries, such as national income and welfare policies. In this section, I provide a more detailed discussion, applied to the body of evidence in the thesis (comparative cohort analysis and critical review), with reference to previous literature.

A number of criteria have been developed to assess causality in epidemiology. The set of criteria developed by Bradford-Hill have been very widely used (Bradford Hill, 1965). However, some of these have criticised, e.g. by (Rothman and Greenland, 2005). More recently, Gordis developed a list of criteria to assess causality (Gordis, 2009). These criteria are outlined in Box 9-1.

Few causal relationships meet all criteria. In reality, causality is a complex process with multiple, often interacting factors. This is particularly the case for complex social factors, such as income inequality and the social determinants of health, which affect health through multiple, complex pathways. Rothman has advocated for a more flexible approach, which takes this complexity into account. In this approach, multiple causes/components are recognised (Rothman and Greenland, 2005). Criteria for causality should therefore not be used as a checklist without careful interpretation, but they can be useful if used flexibly to aid interpretation of evidence. I therefore consider the evidence for the relationship between income inequality and health, with reference to some of the Gordis criteria.

Box 9-1: The Gordis criteria for causal inference

Gordis criteria for causal inference

1) Temporal relationship
2) Strength of the association
3) Dose-response relationship
4) Replication of the findings
5) Biologic plausibility
6) Consideration of alternate explanations
7) Cessation of exposure
8) Consistency with other knowledge
9) Specificity of the association

Source: (Gordis, 2009)

Temporal relationship and cessation of exposure

Clearly, for a causal relationship to exist it is crucial for the exposure to precede the health/disease outcome. My comparative cohort analysis was cross-sectional, as were many of the studies in the critical review, so I could not establish a temporal relationship.

Many of the studies assessing income inequality and health have been cross sectional, but some have investigated temporal associations. In their meta-analysis on the relationship between income inequality and health, Kondo and colleagues conducted a separate analysis of studies that had assessed the relationship of income inequality and mortality over time (9 studies). They reported evidence of a temporal relationship (combined relative risk of mortality: 1.08, CI 1.06-1.10) (Kondo et al., 2009). However, a number of studies have not found a temporal relationship, e.g. (Laporte and Ferguson, 2003) - although this study compared subnational level income inequality, which is less likely to be related to health and wellbeing (Wilkinson and Pickett, 2006). Some studies have found that temporal relationships can be explained by other factors. In a large, cross-national study, Babones found that changes in income inequality over time were correlated with changes in life expectancy and with changes in income inequality over time. However, in regression models controlling for possible confounders, this relationship was no longer statistically significant (Babones, 2008).

Analysing temporal associations poses considerable methodological challenges, for example due to the fact that income inequality is relatively stable over time (Babones, 2008). It is also difficult to determine the time interval between income inequality and health consequences (‘aetiologic period’) (Avendano, 2012) and to identify other factors that could have played a role across the lifecourse (Rowlingson, 2011).

There is growing evidence of a temporal relationship between income inequality and health. However, there is a need for more cross-national studies assessing the relationship over time.

Strength of the association

Gordis suggests that stronger associations are more likely to be causal. Strength of the relationship can be measured using relative risk or odds ratios (Gordis, 2009) – i.e. the slope of the gradient (note that this definition of 'strength' differs from the meaning I have used as a feature of the social gradient throughout the thesis).

The relationship is strongest when we compare countries (or US states); relationships are often weaker or non-existent when we compare smaller areas within countries.

A number of studies have shown that the cross-national relationship between income inequality and health is strong. For example, Babones found that a cross-national 1 point increase in the Gini coefficient corresponded with a decline of 0.39 years of life expectancy in 1995 (Babones, 2008). The strength of the relationship varies by health and wellbeing outcome – it seems to be particularly strong for child wellbeing, teenage birth rates, social mobility, imprisonment and mental illness (Wilkinson and Pickett, 2009b).

When studies have found that the relationship between income inequality and health and wellbeing is weak (often at sub-national level), we should bear in mind that this can still be important for population health. Income inequality affects the whole population, so the impact can be very large at a population level – even if the individual effect size is small. In their meta-analysis, Kondo and colleagues found, overall, that there was an 8% greater mortality risk with each 0.05 unit increase in the Gini coefficient. They wrote that, at a population level, 1.5 million deaths could be averted in 30 OECD countries if their Gini coefficient was reduced to below 0.3 (Kondo et al., 2009).

Finally, we should bear in mind that strength of association does not necessarily imply causality - a factor may be weakly associated, but still causal (Rothman and Greenland, 2005).

Dose-response relationship

Many studies have found that there is a finely-graded relationship between the level of income inequality and health and wellbeing, showing strong support for a dose-response relationship. Most studies have suggested a linear relationship, e.g. (Wilkinson and Pickett, 2009a). However, others have suggested that there is a threshold effect, e.g. Kondo suggested that the relationship may be stronger above a threshold of Gini = 0.3 or higher (Kondo et al., 2009).

Replication of the findings

There have been studies of the association between income inequality and health and wellbeing in different geographical regions and in different time periods. Evidence of a relationship between income inequality and health/wellbeing has been replicated in many studies in high income countries, e.g. (Macinko et al., 2004, Kondo et al., 2009, Pickett and Wilkinson, 2007, Levin et al., 2010). Analyses of US states have further replicated these findings (Wilkinson and Pickett, 2009b). The evidence has been less consistent in low and middle income countries. Some have shown evidence of a relationship, e.g. between countries in Latin America (Biggs et al., 2010); others have shown inconsistencies or no relationship, e.g. in a range of countries (Ram, 2006). Studies conducted after 1990 have shown a more consistent relationship between income inequality and health and wellbeing (Kondo et al., 2009, Wilkinson and Pickett, 2006).

Biologic plausibility, consistency with other knowledge, consideration of alternate explanations, specificity of associations

As discussed in chapter 2, there have been two main models explaining how income inequality affects health: the neo-material and psychosocial models. Our understanding how income inequality affects health is consistent with our understanding of how SEP affects health.

It is easy to understand the neo-material pathways, e.g. how access to health services shapes people's health. The psychosocial pathways can be more difficult to understand (and the research evidence crosses disciplines, with few reviews of this evidence). Several studies have explored whether psychosocial factors moderate the relationship between income inequality and health. For example, Elgar found that levels of trust correlate with national income inequality and partially mediate the relationship with life expectancy in high and middle-income countries (Elgar, 2010). Recently, there has been a growth in research on the biological mechanisms, through which psychosocial factors affect health, for example showing how cortisol levels relate to socioeconomic position (Lupien et al., 2001) and showing that stress can affect the functioning of hormone pathways, with long-term implications for development (Talge et al., 2007). These studies are building up a picture of biological plausibility - how psychosocial factors can 'get under the skin', although further studies and reviews of the cross-disciplinary evidence would be useful.

Could the relationship between income inequality and health be explained by other differences, such as poverty rates or differences in welfare policies? Multilevel modelling strategies have allowed studies to control for differences that could explain the link between income inequality and health at the individual level (composition differences) and country level (context differences). This approach has helped to provide evidence for a causal link by showing that income inequality has an effect, after controlling for other potential explanations (Kondo et al., 2009). However, it is not always clear how other factors relate to income inequality. There are concerns that some studies have adjusted for factors that are actually mediators in the link between income inequality and health (Wilkinson and Pickett, 2006). Some other differences between countries, e.g. the welfare state and social expenditure, are closely related to income inequality and probably interlink to affect health (as discussed in chapter 2).

Specificity of the association means that the exposure is associated with only one disease. Gordis included this in the list, but notes that it is weak and should probably be deleted – many exposures have multiple effects (Gordis, 2009).

In summary, it is very difficult to determine causality for broad social factors, such as income inequality. As Schrecker wrote in a recent commentary on standards of proof required in social epidemiology: “adopting what has been called a tobacco industry standard of proof… with respect to social determinants of health means the evidence may never be strong enough” (Schrecker, In press, page 3). Overall, there is increasing evidence of a causal link between income inequality (at the national or state level) and health and wellbeing. Further research is needed to strengthen this and, in particular, to understand the temporal links, confounding and biological processes.

9.4. The policy implications of the relationship between income inequality, socioeconomic position, and health

This section discusses the implications of the findings from the thesis for policy in high income countries.

Socioeconomic position and income inequality affect children’s health and development and have long-terms impacts on people’s health and wellbeing throughout their lifecourse. Policy changes and interventions therefore have the potential to both improve current child health and development, and to have long-term implications into adulthood (in terms of health, cognitive and socioeconomic achievements).

Policy needs to address the two layers of detriment: from being in less advantaged socioeconomic circumstances and from living less equal countries. Approaches could focus on:

a) Reducing income inequality
b) Reducing the link between income inequality and child health/wellbeing

a) Reduce income inequality and social differentiation

Income inequality has risen since the 1980s in 17 of the 22 OECD countries where data are available (OECD, 2011a). All of the comparative cohort study countries have become more unequal; the more equal countries have not been immune to this trend, indeed OECD data suggests that income inequality has risen particularly sharply in Sweden.

These increases in income inequality have been largely driven by changes in salaries. Other important contributing factors have been less redistribution through taxation and transfers and changes in household structure (although this played a more minor role) (OECD, 2011a). A number of background drivers of these changes have been put forward, including globalisation of the labour market and technological change. Others have drawn attention to institutions and policies, such as the deregulation of markets and the power that workers have to bargain for their working conditions, e.g. through union coverage (OECD, 2011a).

Halting this trend and reducing the level of income inequality in society could have positive effects on health and wellbeing. Even small reductions in income inequality (e.g. moving from the level of income inequality seen in the UK to that experienced in Canada) could bring considerable health and wellbeing improvements.

There are a range of policy options to address the growing gap between the rich and poor. Some are more direct and effective than others, but a range of policies is likely to be the most effective approach. The policy options outlined below reflect the need to tackle income inequality across the whole income distribution. Improving incomes at the bottom of the income distribution can reduce poverty and lift incomes closer to the average income. However, to reduce inequality across society, on its own this is not sufficient.

Redistribution through taxes and benefits

The most direct way to reduce income inequality is through taxes and benefits (OECD, 2011a). Benefit policies can guarantee a minimum income. In countries with social democratic welfare states this minimum level of income meets a more generous, socially acceptable standard of living (Eikemo and Bambra, 2008). However, in many countries the income provided by means-tested benefits is well below this level, including the UK (Davis et al., 2012).

Progressive taxation is an important lever to reduce income inequality – and in turn to improve health (Marmot, 2010). Direct taxes on income tend to have a progressive distribution, although the extent of this varies, with recent reductions in the top income tax brackets in many countries. Indirect taxes, such as VAT, however, tend to be regressive, with people at the bottom of the income distribution spending a higher proportion of their income on indirect taxes (OECD, 2011a).

Both targeted and universal cash benefits play an important role. Benefits that are targeted to those in particular need (e.g. unemployment benefits) ensure that the most vulnerable are protected. However, universal benefits (such as universal child benefit) are also important, providing a social insurance system that everyone pays into and benefits from. Erosion of these principles can stigmatise benefit recipients and reduce the willingness to pay tax for people with higher incomes (McKee and Stuckler, 2011).

Influence the distribution of incomes

Policies can influence the distribution of incomes in the first place. Legislation for a minimum income that is reasonable to be able live a healthy life is critical (Marmot, 2010, Bradshaw et al., 2008). Minimum incomes are widely accepted and implemented in many countries. However, they are often lower than required to live an acceptable standard of living, e.g. in the UK (Davis et al., 2012). Pay ratios have also been proposed to reduce inequality of salaries.

Service provision

Public provision of services, such as education, health services, child care and housing, also has a redistributive effect (discussed in chapter 2). Services are often referred to as 'benefits in kind' – they remove costs for essential services from households. Some services may have further redistributive effects, for example child care allows parents to gain employment and reduces child poverty (OECD, 2011a). As with benefits, both universal services and services targeted at people with low incomes play an important role.

Higher expenditure on services has a greater redistributive effect. Increases in expenditure on services such as health, education and housing over time in the UK have led to increasing effectiveness of services in reducing income inequality (market income inequality has grown, but public services have played an increasing role in reducing the effects of this) (OECD, 2011a).

Other strategies

Many other strategies have been put forward. Investment in human capital through education and training has been put forward as a strategy to reduce inequality in incomes (OECD, 2011a).

Many other approaches focus on employment and organisation of labour markets. Facilitating access to employment for groups who are often excluded from the labour market can reduce poverty, with resultant reductions in income inequality (OECD, 2011a). Single parent households are disproportionately likely to live in poverty in the UK. Strategies to facilitate single parents to return to work, such as subsidised, available child care and employment rights for parents could play a role. A number of approaches focusing on the organisation of labour markets have been proposed, such as encouragement of unionisation, partnership and cooperative organisations, and representation of employees on company boards (Wilkinson and Pickett, 2009b).

b) Reduce the link between income inequality/socioeconomic position and child health/development

Reducing inequalities in health relies, first, on addressing the root causes - reducing the levels of income inequality and poverty in society. However, policy can also focus on reducing the effects of inequality – interventions to give every child the best start in life were singled out as the highest priority recommendation in the recent Marmot review of evidence-based strategies for reducing health inequalities in England (Marmot, 2010).

In order to improve child health and development along the whole social gradient, interventions need to be proportionate to the level of need. Approaches to reducing health inequalities need to focus on 'levelling up' the gradient, not just reducing the gap between the rich and the poor (Bird and Whitehead, 2011). Universal programmes ensure all children get the best start in life; extra, targeted, support for children from more deprived backgrounds focus on the particular needs of the most vulnerable. This approach has been termed 'proportionate universalism' (Marmot, 2010).

In order to reduce the links between income inequality, socioeconomic position and child health and development, interventions need to focus on the pathways identified in Chapter 2. These could focus directly on children, or on families and others in contact with children. There are a wide range of interventions that are effective at reducing inequalities in child health (Roberts, 2012). This section is by no means an exhaustive review – rather, I have briefly discussed a small number of key interventions.

There is a relatively large amount of evidence on what works to reduce health inequalities during pregnancy, early life and pre-school (Roberts, 2012). Interventions are needed to provide support to families and children, for example through children's centres and parenting programmes. A recent review of interventions concluded that approaches that include a combination of centre and home-based approaches, and which focus on both parents and children, are effective at improving cognitive and social-emotional development in early childhood (Geddes et al., 2010). Where day care is provided, the quality is key – poor quality day care can be detrimental; high quality programmes with trained staff can be beneficial, particularly for children from disadvantaged backgrounds (Roberts, 2012). There is some evidence that such approaches can have long-term health, social and economic effects across the lifecourse (Roberts, 2012).

There is also evidence of the benefits of interventions to help parents engage in healthy behaviours, such as breastfeeding, or smoking cessation (Roberts, 2012).

Further support can be provided to families through policies that protect their economic welfare and provide opportunities for parenting. Paid parental leave policies are key and have been shown to improve child health (Marmot, 2010, Heymann et al., 2010).

Much of the evidence on interventions relates to improvements in child health and development overall; further evidence on how interventions can reduce inequalities between children in more and less advantaged circumstances would be useful.

Increasingly, early childhood is singled out as the most important time in people's lives to intervene in order to reduce inequalities, e.g. (Marmot, 2010). Yet spending on early childhood remains low. Public spending on children tends to have an inverted 'U' shape – spending is low in the early years, rises into the early to mid-teenage years and then reduces again (OECD, 2009). A key priority is therefore to increase the proportion of public expenditure on early child development (Marmot, 2010).

9.5. Focus on the UK – child health and development, socioeconomic position and income inequality

The UK was categorised into the most unequal group of countries in my comparative cohort analysis. Child health in the UK was often relatively poor, and health and development inequalities were high. What is the current situation in the UK?

Income inequality in the UK

Income inequality rose steeply during the 1980s in the UK and continued rising until 2010. During the recession, income inequality has fallen steeply. This was related to a fall in earnings across the income distribution during the recession and the protective effects of social transfers. However, the fall is likely to be short-lived, and income inequality is expected to rise again as incomes grow again and regressive tax and benefit changes are implemented (Cribb et al., 2013).

Relative to other OECD countries, income inequality is high in the UK (Figure 8-6). The UK is the most unequal country in Western Europe (based on my comparison using Gini coefficients from the SWIID database).

In the UK, there has been a long-term trend of the top 1% pulling away from the rest of the income distribution, earning around 15% of pre-tax income in 2007 (OECD, 2011a). At the other end of the income distribution, incomes have hardly grown for the bottom 10% of earners. The proportion of the population who live in relative poverty (60% of median income) rose sharply alongside income inequality in the 1980s to 22.2% of the population in 1990 (before housing costs). Since the late 1990s, relative poverty rates fell as redistribution increased and was 15.9% (before housing costs) in 2010-11. However, recent changes reflect falls in the median income during the recession – when we look at absolute poverty rates, there has been a slight rise (Cribb et al., 2013).

Families with children are disproportionately likely to live in relative poverty - 17.4% in 2010-11. Child poverty rates have fallen alongside total poverty rates. In the recent UNICEF report card on child wellbeing, the rate of child poverty in the UK ranked about half-way among rich countries – rates were considerably higher than Northern European countries, but much lower than in Canada and the United States (UNICEF Office of Research, 2013).

To assess inequality of incomes, we need to take costs of living into account. At the bottom of the income distribution, incomes are insufficient for healthy life. Studies have defined a minimum income standard for the UK (Bradshaw et al., 2008). This has been defined as "the income that people need in order to reach a minimum socially acceptable standard of living in the UK today, based on what members of the public think" (Davis et al., 2012, page 7). However, many groups fall short of meeting these standards, and as costs for families with children have risen, it has become particularly difficult for families to achieve minimum income standards. In 2012 the minimum wage was £6.19 an hour; for a couple who are both working full-time with two children, each would have to make £9.91 an hour to meet the minimum income standard (Davis et al., 2012).

Looking beyond income, the UK is marked by high levels of social disadvantage and inequality. For example, inequalities in educational attainment are large in the UK (OECD, 2013, OECD, 2010). This was confirmed by my findings in the comparative cohort analysis - for 14% of children in the MCS neither parent had secondary qualifications (GCSE grades A-C or above). This was higher than observed in any of the other countries I included; in the Netherlands and Sweden there were no children with parents who had not completed secondary school education.

Finally, there is less opportunity to move out of the socioeconomic position that people were born into in the UK than other countries - social mobility is relatively low. A recent OECD report found that intergenerational mobility in earnings was particularly low in the UK (OECD, 2008), and people's education and skills are closely related to their parents' education levels (OECD, 2013).

In summary, although there were signs that the income distribution was becoming more equal from the late 1990s, the UK still stands out as particularly unequal in comparison with other countries. There are also concerns that recent policies will further increase income inequalities in the UK in future years.

Child health and development

There have been great improvements in child health, development and wellbeing in the UK over recent decades. Child subjective wellbeing has generally been improving in the UK since the mid-1990s (children have reported steadily higher life satisfaction scores), but there is some indication that wellbeing may have started to fall since 2008 (Rees et al., 2013).

Yet, in comparison to other countries, children in the UK often fare worse overall, and inequalities are very large. It is difficult to assess the extent of inequality in child health and development in the UK, relative to other countries, due to lack of comparable data. However, there are some international comparisons of average child health. Many widely used health indicators suggest that children in the UK are less healthy, on average, than children in other high income countries. This can be seen from birth. For example infant mortality rates are relatively high (just above the OECD average), and children are considerably more likely to be born with a low birthweight in the UK than the average in OECD countries (OECD, 2011b). In infancy, breastfeeding rates are relatively low in the UK and infants less likely to receive essential immunisations than in most OECD countries (OECD, 2009). In adolescence, there are particular problems with teenage drinking and pregnancy in the UK (OECD, 2011b). Child overweight and obesity are also large and growing problems in the UK (OECD, 2011b).

In the 2007 league table on child wellbeing published by UNICEF (measuring factors including material wellbeing, housing and environment, education, health and safety and risk behaviours), the UK ranked last (out of 21 countries) (UNICEF Office of Research, 2007). In the most recent report, in 2013, there was some improvement, and the UK was ranked 16th overall (out of 29 countries). Some of this change may have been related to differences in components of wellbeing and the change in the sample of countries. Children in the UK fared particularly poorly in relation to education (UNICEF Office of Research, 2013). Components of the UNICEF index on child wellbeing have been shown to relate to the level of income inequality in countries (Pickett and Wilkinson, 2007).

9.6. Evidence and methods for researching social gradients in child health and development in relation to income inequality

This section discusses both the evidence and methods that I have employed in this thesis, and the evidence and methods needed to further research in this area.

Harmonising cohort studies to compare social gradients in health– my approach

In this thesis, I reported the background literature review, critical review of previous studies and comparative cohort analysis that I conducted in order to compare social gradients in child health and development.

I developed research questions and analytic approaches (in the critical review and comparative cohort analysis) that clarified the key features of the gradient for comparison. Social gradients are complex to research. The 5 features of the gradient (level, slope, strength, length, curvilinearity) are distinct and important concepts (Willms, 2003). There have been few previous comparisons of these different features of social gradients: there has been some useful and very thorough comparison of social gradients in literacy e.g. (OECD, 2010), however there has been previously been less emphasis on such detailed comparisons of the social gradient in child health. By focussing on both the level and slope in my research questions, I was able to assess whether people from all socioeconomic backgrounds do better in societies with greater income equality.

Few previous studies have considered how differences in social gradients related to income inequality (see chapter 4). In my critical review, I therefore combined data from previous studies that had compared social gradients in health or wellbeing between societies with data on income inequality. I also conducted an original comparative analysis of social gradients in relation to income inequality to augment this evidence.

I harmonised data from 7 cohort studies in 6 different countries to compare social gradients in child health and development. A number of studies have previously compared data from multiple surveys or cohorts (reviewed in chapter 4), however these were usually on a much smaller scale, comparing 2 3 or 4 datasets. Comparing 7 different datasets presented a number of challenges:

First, there were considerable logistic challenges in terms of gaining permission to analyse the cohorts and physically accessing data (I spent time in Canada, the Netherlands and Sweden to access data).

Second, there were a number of conceptual challenges to research across multiple datasets. I therefore conducted thorough reviews of previous approaches to harmonisation (chapter 5) and measurement and comparison of health inequalities (chapter 3), in order to inform my study. For some of the cohorts, it was not possible to revisit the data after the initial analysis, so my approach had to be carefully planned in advance. I developed a very detailed strategy for harmonising the samples and variables. This approach minimised variations between the studies as far as possible. Some differences remained, which were discussed in chapter 8. Nevertheless, overall I achieved a high level of comparability despite the large number of differences between datasets. This approach enabled me to develop some useful findings to contribute to the evidence base on how the benefits of greater income inequality and distributed throughout society.

The research implications: strengthening the evidence base

My comparative cohort study has provided some evidence on how the social gradient in child health and development relates to income inequality. However, it was hindered by the data available - further analysis using larger number of countries, more comparable data and a range of analytic methods would be useful. There are two key implications for future research.

First, my research has highlighted the lack of comparable, reliable, individual level data on early childhood. There are a number of international, comparable surveys which provide data on adult health and wellbeing, including the EU-SILC (income and living conditions). Comparable data on adolescent literacy in the PISA (Programme of International Student Assessment) studies has enabled detailed comparisons of social gradients between countries, e.g. (OECD, 2010). Comparable data on adolescent health and wellbeing were also collected through the HBSC study (Currie et al., 2008a, Currie et al., 2012). However, no international, comparable surveys on the health and development of young children are available.

Early child development is now being routinely monitored in Canada and Australia using the Early Development Instrument (EDI) (UNICEF Office of Research, 2013), and this has recently been piloted in other countries, including Scotland. However, the majority of high income countries lack any regular monitoring of child development in early years.

Recent reports on child wellbeing have also pointed out this lack of data on early childhood, e.g. (UNICEF Office of Research, 2013). This may result from methodological difficulties in measuring child development and the lack of a widely applicable measure, or be due to the importance of early child development only recently being recognised (UNICEF Office of Research, 2013).

Without reliable, comparable data, it is very difficult to conduct cross-national comparisons, develop evidence for policy and monitor progress. This lack of evidence for policy is especially worrying, given the importance of early child development for health and wellbeing throughout the lifecourse (Irwin et al., 2007).

Second, a range of analytic approaches are required in order to fully understand how the social gradient in child health and development is related to income inequality. Further analysis of social gradients using the methods used in the comparative cohort study using comparable data would be useful – this would enable more valid comparisons of the gradient (in particular of the level of health in each socioeconomic group).

Analysis can employ multilevel modelling approaches to test the relationship between income inequality at a country (context) level and socioeconomic position at a family/individual (composition) level. Including cross-level interactions can identify how income inequality moderates the relationship between income inequality and health. These approaches have been employed for data on adolescents and adults e.g. (Levin et al., 2010), but the lack of comparable, individual level data on early childhood from a wide range of countries hinders this approach to understanding child health and development. Further understanding of the mechanisms through which income inequality affects child health would also be useful, for example examining the role of both psychological differences and differences in policy and services between countries, at different levels (e.g. family, neighbourhood, country).

Chapter 10: Conclusions

In this thesis, I have explored how the social gradient in child health and development varies in relation to income inequality in high income countries. I have achieved this through:

1) Reviewing approaches to measuring and comparing the social gradient in child health and development
2) Reviewing studies that have compared the social gradient in health and wellbeing between high income societies with different levels of income inequality
3) Analysing and comparing social gradients in child health and development using data from high income countries with different levels of income inequality
4) Summarising and discussing current evidence on social gradients in child health and development in relation to income inequality

These approaches enabled me to compare both the level and slopes of social gradients in child health and development in more and less equal societies.

From this work, 5 key conclusions have been reached. These are outlined below, with a focus on the UK, as well as more general conclusions.

1) At age 5 there are socioeconomic inequalities in child health/development, across a range of physical, socio-emotional/behavioural and cognitive outcomes.

Children's socioeconomic environment matters for their early health and development. Inequalities are clearly evident by age 5: social gradients in child health and development were observed across a range of physical, socio-emotional/behavioural and cognitive outcomes. There were some variations between outcomes and countries.

The social gradient in health and development affects nearly everyone. Health and development are often poorer with every step down the social ladder, in terms of parental education or household income de. This means that children across the whole of society are faring worse than they could if they lived in more socioeconomically advantaged circumstances.

These inequalities are damaging for children early in life; they also have long-term health, wellbeing and socioeconomic implications into adulthood. This compromised health and development also has long term implications into adulthood.

2) The observation that social gradients are shallower in some countries than others shows that such inequalities are not inevitable.

For some outcomes there was a clear difference in the extent to which children's socioeconomic position influenced their level of health and development. The steep gradients in height that we see in the UK are not seen in Sweden, for example – they could be avoided. Likewise, the steep gradient in verbal cognition by age 5 in the UK (children whose parents do not have secondary qualifications are 15 months behind children with one or more parent with a degree) was not observed in Canada (where the parental education gap was 9 months). This finding is backed up by previous literature: many studies have found stark differences in the extent of socioeconomic inequalities in health and wellbeing between countries.

This pattern was not evident for all outcomes, however. For example, steep social gradients in overweight and obesity were evident in all countries studied.

Differences in social gradients between countries have a moral dimension. If these inequalities are not inevitable, they are also unfair and could be avoided.

3) The growing evidence that everyone does better in more equal countries suggests that if countries were more equal, children from all social backgrounds would benefit.

My critical review, together with my comparative cohort analysis, provide some support to the view that everyone benefits from living in a more equal society. In societies that are more equal, people from disadvantaged backgrounds benefit a lot, but people from advantaged backgrounds may also benefit. In other words, there is a 'fanning out' effect.

This means that children across the whole of society are faring worse than they could if they lived in more equal countries.

There were difficulties in assessing this in the comparative cohort study, due to measurement differences. However it was clearly evident that children from all socioeconomic backgrounds are taller in more equal countries, with greatest benefits among children living in disadvantaged circumstances. There was some evidence of this for some other outcomes, although there were some inconsistencies and the pattern was not evident for other outcomes, e.g. overweight and obesity. It could not be assessed for some other outcomes. The critical review of previous studies showed that many previous studies have also indicated a fanning-out effect. However, there is a need for further research on this topic using comparable data.

This has important policy implications. Growing evidence that having a more equal society would benefit people from all social backgrounds gives greater policy impetus to reduce the level of income inequality.

Reducing income inequality could have numerous benefits for people across society. There is a need for greater policy focus on reducing income inequality in high income countries. This is particularly the case for the most unequal countries, e.g. the US and UK. However, given rises in income inequality in many high income countries over recent decades, there needs to be widespread policy commitment to tackling income inequality. A range of policy approaches can be used, e.g. redistribution, public services, and policies to influence the distribution of incomes.

Alongside this, interventions are required to reduce the links between children's health and development and living in an unequal society or living in disadvantaged socioeconomic circumstances.

4) High income inequality in the UK has detrimental effects on population health

Income inequality is high in the UK. This has previously been shown to be detrimental to health and wellbeing for people in the UK, on average. Growing evidence also suggests that everyone is suffering the effects of living in an unequal society. Steep socioeconomic differentials in the UK also translate into steep inequalities in child health and development. My comparative cohort analysis showed steep social gradients for all the child outcomes I studied in the UK: height, overweight/obesity, general health, chronic illness, emotional problems and anxiety, hyperactivity and inattention, and verbal cognition.

There is an urgent need to reduce the level of income inequality in society, and for policies and interventions to break the links between socioeconomic circumstances and children's health and development.

5) There is a great need for comparable data on early childhood health and development in high income countries

Comparisons of social gradients in child health and development between countries required comparable, individual level data.

I developed comparable datasets by harmonising data form multiple cohort studies. This posed many challenges, due to the differences in design and measurement between cohorts, and contextual differences. However careful consideration of these issues and mapping the differences between datasets enabled harmonisation of the samples and variables. Differences could not be completely eliminated, and findings needed to be interpreted with these variations in mind. This yielded useful comparisons between datasets. This process showed that harmonising cohort datasets is both feasible and beneficial to comparative research.

Although there are international surveys of health and wellbeing among adolescents and adults, there are no international surveys of early child health and development. Individual level, comparable data on children in the early years of life are essential for research comparing early childhood and the factors that shape children's health and development between countries. Such research is needed in order to inform policy and interventions to give children the best start in life.

Appendices

Appendix 2: Further information for chapter 2

A.2.1 Ecological analysis of child health and development and income inequality

Introduction

Many studies have found a relationship between income inequality and health and wellbeing at the national level and sub-national level (e.g. between states in the US)(Wilkinson and Pickett, 2006). However, this relationship has been inconsistent and there is some uncertainty about the strength of evidence for associations between income inequality and health and wellbeing (Lynch et al., 2004).

One explanation that has been put forward is that the association between income inequality and health is stronger for health outcomes with a social gradient (i.e. for outcomes for which each incremental improvement in socioeconomic status confers health advantages, such as infant mortality). Previous analysis has supported this: mortality rates with steep socioeconomic gradients have been found to be more sensitive to income inequality than those with flatter gradients at the state level in the US (Wilkinson and Pickett, 2008). However, this has not been explored in relation to child health and development (including physical health and development, socio-emotional development and cognitive development).

This analysis aims to answer the following questions for selected indicators of child health and development:

- Is there a social gradient in each indicator of child health and development within countries?
- Is there a relationship between each indicator of child health and development at the country level and a) national wealth, b) national income inequality?
- Is the relationship with income inequality stronger for indicators which have a social gradient?

Methods

Literature review

I conducted a brief literature for each child health and development variable to answer the question: Is there a social gradient in each indicator of child health and development within countries?

Ecological analysis

Ecological analysis was conducted to answer the questions:

- Is there a relationship between each indicator of child health and development at the country level and a) national wealth, b) national income inequality?
- Is the relationship with income inequality stronger for indicators which have a social gradient?

I initially included all OECD countries. I then excluded the following countries from the analysis:

- All countries with a GDP below US$10,726 (i.e. I excluded all countries below the World Bank cut-off for a high income country – see figure A.2-1). This is because I am interested in high income countries, in which there is not a relationship between GDP and health/social outcomes. (10 countries excluded)
- Luxemburg. This is because Luxemburg is a small country with a very high GDP. (1 country excluded)

Following these exclusions, 29 countries were included in the analysis.

I used the following variables in the analysis:

- Gini coefficient – LIS wave vi (year ranged between 2003-2006; most were in 2004)
- GNI – World Bank atlas method, USD, 2005

I selected child health and development indicators that were available from the OECD (OECD family database). I chose indicators within each of three categories of child health and development: physical health and development, socio-emotional development/behaviour and cognitive development. Table A.2-1 shows the indicators selected for analysis.

Figure A.2-1: Scatterplot of GNI per capita (2005) and post-neonatal mortality (2008), with a reference line showing the cut-off for World Bank high income country categorisation[2]

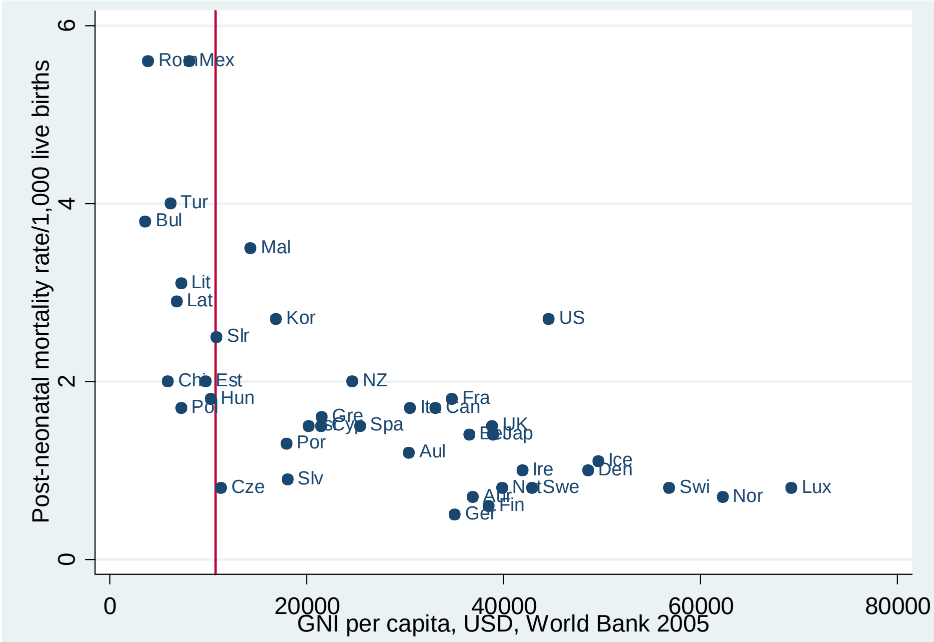


Table A.2-1: Child health and development indicators selected for analysis

Health and development category	Indicator	Details	Source
Physical health and development	Post-neonatal mortality rate/1,000 live births	Year: 2008 Postneonatal mortality may be more useful for international comparisons than infant mortality, as it excludes measurement problems	OECD Family database
	Asthma prevalence (proportion who have ever had asthma)	Year: 2002 Ages 6-7 and 13-14 years	OECD Family database
	Teenage overweight (percentage with self-reported overweight)	Year: 2005/6 Age: 15	OECD Family database
Socio-emotional development/ behaviour	Teenage suicide rate/100,000	Years: 2003-2008 (most 2007) Ages 15-19	WHO mortality database
	Teenage smoking prevalence (proportion who smoke at least once a week)	Year: 2005/06 Age: 15	OECD Family database
Cognitive development	Literacy (reading, mathematics and science) at ages 10 and 15		OECD Family database - TIMS, PIRLS, PISA

[2] The World Bank classifies economies according to gross national income (GNI) per capita (calculated using the World Bank Atlas method). In 2005, the groups were: low income, $875 or less; lower middle income, $876-$3,465; upper middle income, $3,466-$10,725; and high income, $10,726 or more.

I conducted Pearson's correlations to test the strength of the relationship between: a) the country income (GNI per capita) and the country-level child health indicators; and b) the level of income inequality in the country (gini) and country-level child health indicators.

I have reported the r value and the p-value for each correlation. I have presented scatterplots for both GNI and gini and each outcome. I have included a line of best fit when p<=0.05.

Literature review

a) Post-neonatal mortality

There is strong evidence of a steep social gradient in *infant mortality* in different countries and by different indicators of SEP. For example, gradients have been described by father's social class in the UK and Sweden (Leon et al., 1992), by area deprivation in the UK (Norman et al., 2008). Although there is less evidence on *post-neonatal mortality*, studies have shown a steep gradient, for example by maternal education in the Nordic countries (Arntzen et al., 2008) and by father's social class in the UK (Maher and MacFarlane, 2004). There is also evidence of steep social gradients in the component causes of post-neonatal mortality, including Sudden Unexpected Death in infancy (Spencer and Logan, 2004). We can therefore conclude that there is a social gradient in post-neonatal mortality.

b) Child and teenage asthma (prevalence and severity)

Child and teenage asthma were previously thought to not have a social gradient. A review published in 1996 showed that most studies did not find an association between SEP and child asthma, and those reporting an association had conflicting findings (MIELCK et al., 1996). This has been supported by more recent studies, for example study from the United States using a large, nationally representative sample of year olds found no association with various indicators of SES (Goodman, 1999). Yet, other studies have found evidence of a gradient in the United States (Victorino and Gauthier, 2009).

However, there may be differences by severity of asthma. A German study screened children aged 9-11 for asthma and grouped them by asthma severity. They found that the prevalence of severe asthma was significantly higher in the low compared with the high socioeconomic group (measured using parental education) (MIELCK et al., 1996). This is supported by a study in Rome: child (age 6-7) asthma was found to be associated with parental education, but the association was stronger for asthma severity and lifetime hospitalisation for asthma was strongly associated with parental education and area-based disadvantage (Cesaroni et al., 2003).

In summary, evidence on social gradients in asthma prevalence is mixed. However, there is evidence of a social gradient in severe asthma.

c) Child and teenage overweight/obesity

The social gradient in child and teenage overweight and obesity has been well described.

In England, there is a gradient relationship with area deprivation. The higher the level of deprivation, the higher the prevalence of obesity among children aged 4-5, from 6.6% in the least deprived tenth of areas to 12.2% in the most deprived tenth of areas. Among children aged 10-11, these figures are 12.6% to 22.8% (National Obesity Observatory, 2010). Steep gradients have also been described by household and parental socioeconomic position, including income and occupation(National Obesity Observatory, 2010). Similar steep gradients exist in the United States, including by parental socioeconomic position among high school students (Goodman, 1999).

d) Teenage suicide

There have been a number of studies of inequalities in adult suicide rates, but there are few studies of youth suicide.

Increased risk of suicide or suicide attempts have been described for various indicators of low socioeconomic status, for example among people with low income in South Korea (Hong et al., 2011) and among people with low occupational status or unemployed in Australia (Taylor et al., 2004). Evidence on whether suicide is more common in deprived areas has been conflicting. A systematic review found that 55% of studies on area-level suicide and socioeconomic position yielded non-significant results, 32% showed a significantly higher suicide in low SEP areas (inverse relationship), and 14% found higher suicide rates in high SEP areas (direct relationship) – with studies using smaller sized areas more likely to report a significant inverse relationship (Rehkopf and Buka, 2006).

There may be differences by gender. One study comparing inequalities throughout Europe found that for both men and women, being a tenant rather than a homeowner was associated with increased risk of suicide. However, lower education status was related to suicide risk for men, but had an inconsistent relationship for women (LORANT et al., 2005). Likewise, in the Australian, education had a significant relationship with suicide only for men (Taylor et al., 2004).

In terms of teenage suicide, studies are both few and inconsistent. A study from the US using a large, nationally representative sample found that SES was not consistently associated with having attempted suicide among high school students (Goodman, 1999). However, a case-control study in Denmark found that parental low income and unemployment were associated with teenagers suicide (although this relationship was reduced after adjustment for family mental illness) (Agerbo et al., 2002).

There seems to be a social gradient in suicide among men, but less consistent inequalities among women. Evidence on teenage suicide is insufficient to draw conclusions on whether there is a social gradient.

e) Teenage smoking (prevalence and severity)

There are some inconsistencies between studies, although on balance there is some evidence of a social gradient. A review found that “15 of 21 [high quality] studies, or 71%, found some support of a negative association between SES and cigarette smoking” in adolescence (Hanson and Chen, 2007, page 265).

Smoking behaviour varies and there are many ways that smoking can be measured, e.g. current or past smoking, regularity of smoking, quantity of cigarettes. There is a social gradient in heavy/severe smoking. For example, a study from Scotland found that teenagers from unskilled backgrounds are less likely to be occasional smokers and much more likely to smoke large numbers of cigarettes (Sweeting and West, 2001).

f) Reading, mathematics and science literacy

The steep social gradient in literacy has been well described (Marmot, 2010). International surveys have revealed inequalities in literacy in the UK and other countries – children from more advantaged backgrounds perform better in literacy tests (OECD and Statistics Canada, 2000, Marks, 2005).

Hypotheses

We expect that the outcomes that have a social gradient will also have a relationship with income inequality. The following table summarises the findings from the literature review on whether there is a social gradient and the expected relationship with income inequality. Differences by gender will be explored for teenage suicide and teenage smoking prevalence.

Table A.2-2: Social gradients and the expected relationship with income inequality for each child health/development indicator

Indicator	Expected relationship with income inequality			Comments
	No/shallow social gradient; no relationship expected between income inequality and indicator	Steep social gradient; relationship expected between income inequality and indicator	Unclear	
Post-neonatal mortality rate/1,000 live births		X		
Asthma prevalence (proportion who have ever had asthma)		X (for severe asthma)	X	Possible differences by severity
Teenage overweight (percentage with self-reported overweight)		X		
Teenage suicide rate/100,000			X	Possible gender differences
Teenage smoking prevalence (proportion who smoke at least once a week)			X	Possible gender differences
Literacy age 10 and 15		X		

Findings from the ecological analysis

In this section I report findings from initial correlation analyses and linear regression analyses. I have shown scatterplots with a line of best fit when correlation and regression analyses indicated a significant relationship.

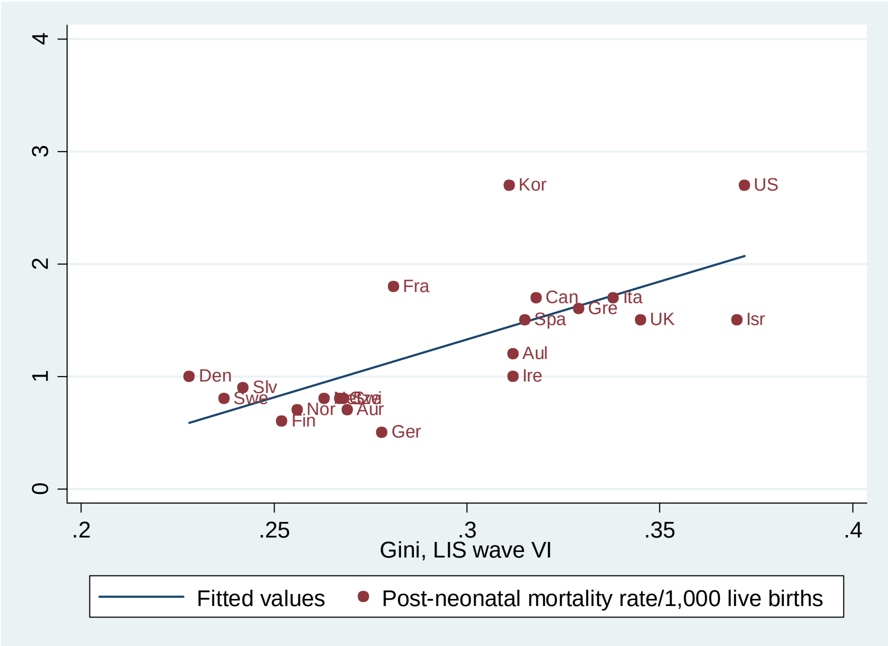
a) Post-neonatal mortality

Post-neonatal mortality was not related to GNI, however there was a strong relationship with the level of income inequality – post-neonatal mortality rates were higher in less equal countries (Table A2-3 and Figure A.2-2).

Table A.2-3: Correlation between post-neonatal mortality and the GNI and Gini coefficient

Child health/development indicator	Correlation with GNI (n)	Correlation with Gini (n)
Post-neonatal mortality rate/1,000 live births	r=-0.47 p=0.01 (29)	r=0.70 p=0.00 (21)

Figure A.2-2: There is a strong, significant relationship between income inequality and post-neonatal mortality – post-neonatal mortality is higher in more unequal countries



The relationship between income inequality and postneonatal mortality is still significant after controlling for GNI per capita. Including both the gini and GNI per capita in a linear regression model gave an R-squared of 0.5046, i.e. it explained about half of the variance (Table A.2-4).

Table A.2-4: Linear regression of post-neonatal mortality on the GNI and Gini coefficient

	Coefficient	**95% CI**	**p-value**
Gini coefficient	9.92	4.59 - 15.26	0.00
GNI per capita	-4.81e-06	-.00 - .00	0.57
Constant	-1.48	-3.33 – 0.36	0.11

Prob > F = 0.0018, R-squared = 0.5046

b) Asthma prevalence and severity

The proportion of children who had ever had asthma (and severe asthma) among 6-7 year olds and 13-14 year olds was generally not related to the GNI (with the exception of severe asthma among 13-14 year olds, which was borderline significant) and was not related to income inequality. The correlation coefficients are shown in Table A.2-5.

Table A.2-5: Correlation between asthma (prevalence and severity) and the GNI and Gini coefficient

Child health/development indicator		Correlation with GNI (n)	Correlation with Gini (n)
Age 6-7 years	Moderate - Proportion who have ever had asthma	r=0.01 p=0.97 (14)	r=0.54 p=0.14 (9)
	Severe - Proportion who have had 4 or more asthma attacks	r=0.11 p=0.71 (14)	r=0.29 p=0.44 (9)
Age 13-14 years	Moderate - Proportion who have ever had asthma	r=0.36 p=0.19 (15)	r=0.25 p=0.46 (11)
	Severe - Proportion who have had 4 or more asthma attacks	r=0.52 p=0.05 (15)	r=0.24 p=0.48 (11)

Asthma data were collected in 2002. This is before the GNI and Gini data.

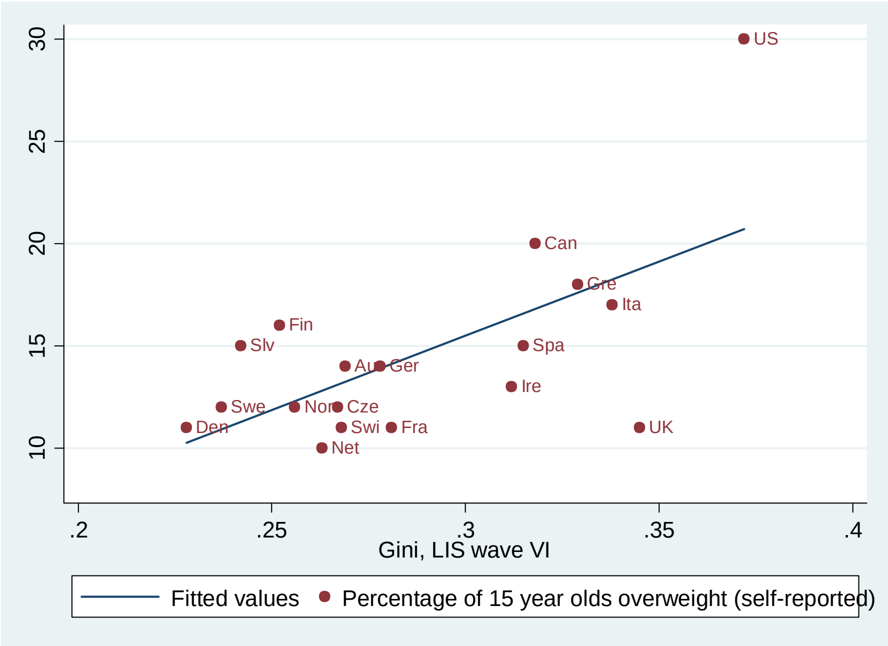
c) Teenage overweight

There was a significant correlation between teenage overweight (self-reported) and income inequality (Table A.2-6 and Figure A.2-3).

Table A.2-6: Correlation between teenage overweight and the GNI and Gini coefficient

Child health/development indicator	Correlation with GNI (n)	Correlation with Gini (n)
Percentage of 15 year olds who are overweight (self-reported)	r=-0.18 p=0.41 (23)	r = 0.64 p = 0.00 (18)

Figure A.2-3: There is a significant relationship between income inequality and teenage overweight – teenage overweight is more prevalent in more unequal countries



The relationship between income inequality and overweight was still significant after adjustment for GNI per capita. The R-squared was 0.4, indicating that the model explained 40% of the variance in overweight prevalence (Table A.2-7).

Table A.2-7: Linear regression of teenage overweight on the GNI and Gini coefficient

	Coefficient	**95% CI**	**P-value**
Gini coefficient	72.20	23.20 - 121.31	0.01
GNI per capita	-9.67e-06	-.0002 - .0002	0.90
Constant	-5.83	-22.06 - 10.40	0.46

Prob > F = 0.0203, R-squared = 0.4052

d) Teenage suicide

There were no significant relationships between teenage suicide and the GNI or Gini coefficient. This was the case for boys and girls. The correlation coefficients are shown in Table A.2-9.

Table A.2-8: Correlation between teenage suicide and the GNI and Gini coefficient

Child health/development indicator		**Correlation with GNI (n)**	**Correlation with Gini (n)**
Prevalence of suicide among 15-19 year olds/100,000	Total	r=0.10 p=0.60 (28)	r = -0.23 p = 0.31 (21)
	Male	r= 0.05 p= 0.79 (28)	r= -0.17 p= 0.46 (21)
	Female	r= 0.22 p= 0.27 (28)	r= -0.31 p=0.17 (21)

e) Teenage smoking

There were no significant correlations between teenage smoking (proportion of 15 year-olds who smoke at least once a week) and the GNI or Gini coefficient. This was the case for boys and girls. The correlation coefficients are shown in Table A.2-10.

Table A.2-9: Correlation between teenage smoking and the GNI and Gini coefficient

Child health/development indicator		Correlation with GNI (n)	Correlation with Gini (n)
Proportion of 15 year-olds who smoke at least once a week, 2005/06	Total	r=-0.33 p= 0.13 (23)	r = -0.19 p = 0.44 (18)
	Male	r=-0.34 p= 0.11 (23)	r=-0.25 p= 0.32 (18)
	Female	r=-0.29 p= 0.18 (23)	r=-0.11 p= 0.67 (18)

f) Reading, mathematics and science literacy

Initial correlation analyses showed some evidence of relationships between income inequality and literacy. The correlations shown in Table 1.2-11 were further explored using linear regression. The relationship is graphed in Figure A.2-4.

Table A.2-10: Correlation between literacy and the GNI and Gini coefficient

Child health/development indicator		Correlation with GNI (n)	Correlation with Gini (n)
Age 10 years	Reading (PIRLS)	r=-0.00 p= 0.99 (20)	r=0.08 p=0.78 (15)
	Mathematics (TIMS)	r=0.21 p= 0.41 (17)	r=0.41 p=0.17 (13)
	Science (TIMS)	r=-0.04 p= 0.88 (17)	r=0.60 p=0.03 (13)
Age 15 years	Reading (PISA)	r=0.24 p= 0.23 (27)	r=-0.10 p=0.67 (21)
	Mathematics (PISA)	r=0.24 p= 0.24 (27)	r=-0.45 p=0.04 (21)
	Science (PISA	r=0.17 p= 0.39 (27)	r=-0.32 p=0.16 (21)

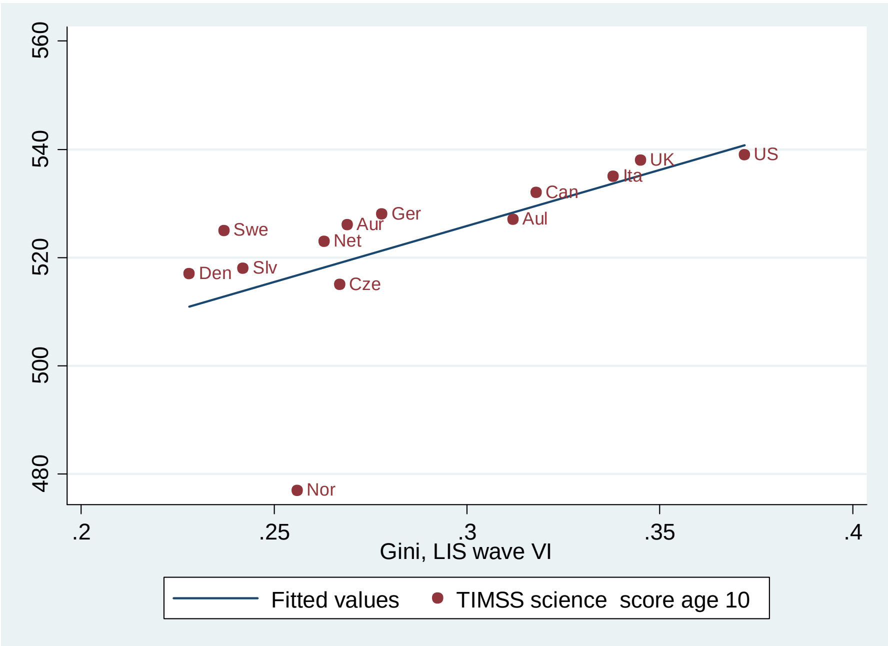
There is evidence of a positive relationship between income inequality and science aged 10, i.e. science literacy is higher in more unequal countries. This relationship is still significant after adjusting for GNI per capita in a linear regression model. The model explains 48% of the variance in science literacy aged 10 (Table A.2-11).

Table A.2-11: Linear regression of science literacy age 10 on the GNI and Gini coefficient

	Coefficient	95% CI	P-value
Gini coefficient	201.14	25.22 - 377.05	0.03
GNI per capita	-.0004	-.0011 - .0002	0.16
Constant	481.05	424.33 537.76	0.00

Prob > F = 0.0383, R-squared = 0.4792

Figure A.2-4: There is evidence of a relationship between income inequality and science aged 10 – science literacy is higher in more unequal countries



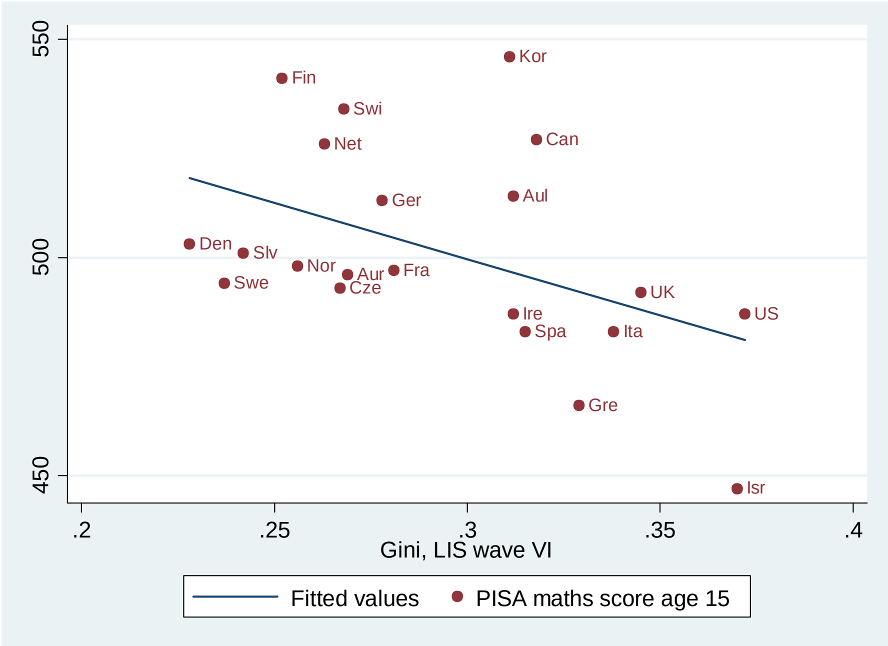
There is evidence of a negative relationship between income inequality and mathematics aged 15, such that mathematics literacy is higher in more equal countries. This relationship is no longer significant after adjusting for GNI per capita in a linear regression model (Table A.2-12).

Table A.2-12: Linear regression of mathematics literacy age 15 on the GNI and Gini coefficient

	Coefficient	95% CI	P-value
Gini coefficient	-241.71	-501.20 - 17.79	0.07
GNI per capita	.0001859	-.0007 - .0010	0.65
Constant	565.81	476.03 - 655.60	0.00

Prob > F = 0.1128, R-squared = 0.2153

Figure A.2-5: There is evidence of a relationship between income inequality and mathematics aged 15 – mathematical literacy is higher in more equal countries



Discussion and Conclusions

The analysis has a number of limitations:

- Data availability – Firstly, income inequality and health and development data were only available for a subset of OECD countries. This meant that a large number of countries were not included in some of the correlations. Secondly, there were limitations in the health and development outcome variables available. For example, it would have been interesting to investigate IQ, but international data on IQ were not available.
- Multiple hypothesis testing – In total I conducted Pearson's correlations between 32 pairs of variables. I used a significance cut-off of p=0.05. Therefore we would expect at least one of the correlations to be statistically significant by chance alone.

In summary, there was evidence of a relationship with income inequality for four child health and development outcomes.

I had identified that there was evidence of a social gradient for four outcomes: post-neonatal mortality, asthma, teenage overweight and literacy. There was no or unclear evidence of a social gradient for the other outcomes. I therefore hypothesised that there would be a relationship between income inequality and the four outcomes with a social gradient.

The findings partially support these hypotheses. There was evidence of a positive relationship with income inequality for post-neonatal mortality and teenage overweight, as predicted. These relationships were still significant after adjustment of GNI per capita. However, there was no evidence of a relationship with income inequality for asthma. For literacy, I looked at reading, mathematical and science literacy at age 10 and 15. The results were mixed. There was evidence of a negative relationship between income inequality and mathematics aged 15 (i.e. mathematical literacy is higher in more equal countries). But this was no longer significant after adjustment for GNI per capita. However, I found a positive relationship with income inequality for science literacy at age 10 (i.e. science literacy was higher in more equal countries), which was still significant after adjustment for GNI per capita. There was no relationship with the other literacy variables.

There was no relationship between GNI per capital and any of the child health and development outcomes.

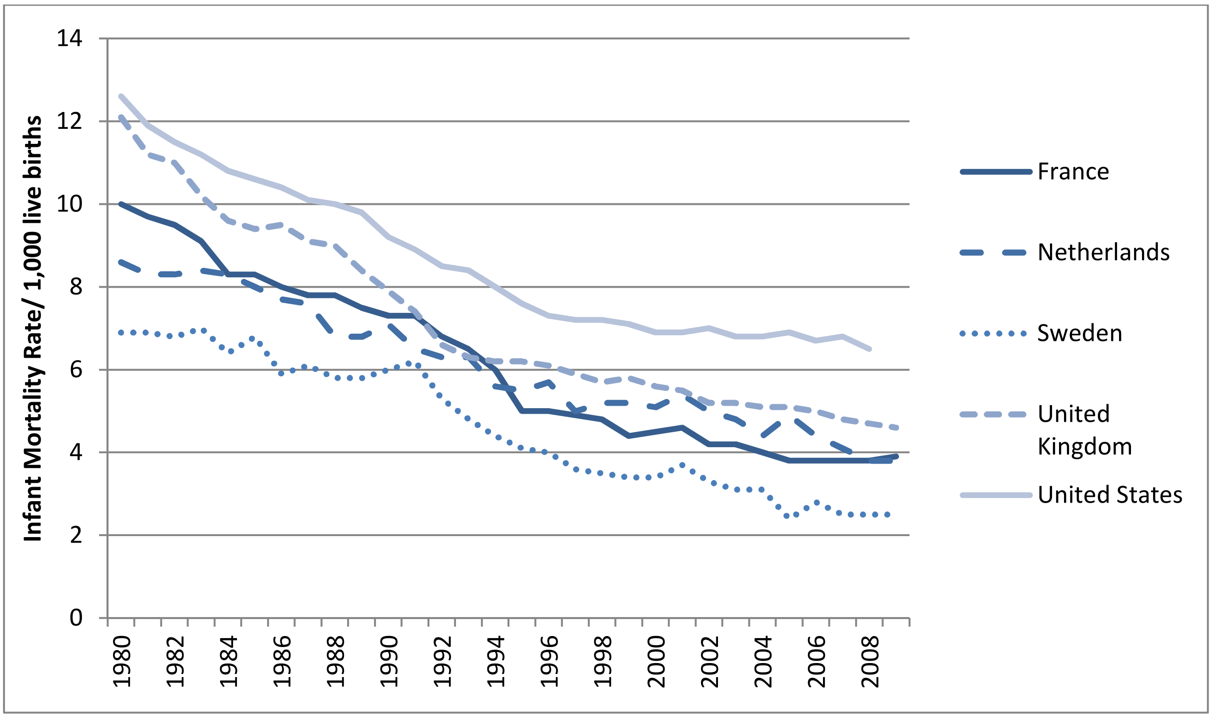
Appendix 3: Further information for Chapter 3

A.3.1 The measurement of infant mortality and implications for international comparisons

Introduction

There have been rapid declines in infant mortality in high income countries, yet wide differences in the probability of infants dying in the first year of life remain between countries. In 2008 the infant mortality rate in Sweden was 2.5 per 1,000 live births, less than half the rate in the United States at 6.8 per 1,000 live births (Figure A.3-1). These differences are frequently used to compare different levels of health and wellbeing between countries. Infant mortality is frequently cited as an indicator of how countries are performing in terms of infant and child health, or health in general, and many organisations produce international comparisons and rankings e.g. (OECD, 2011b). Infant mortality figures are also used to represent or as components of wider issues, including as components of indices of child wellbeing, for example in Europe (Bradshaw and Richardson, 2009) and the United States (Hur and Testerman). Yet despite their wide use, there is limited critique of the validity of international comparisons of infant mortality figures.

Figure A.3-1: Trends in Infant Mortality Rates in selected high income countries, 1980-2009



Source: OECD health statistics

The infant mortality rate is defined as the *"yearly rate of deaths in children less than one year old* (Last, 2001, p.94). It is calculated as:

$$\frac{\text{Number of deaths in a year of children less than one year of age}}{\text{Number of live births in the year}} \times 1000$$

Although the definition of infant mortality is clear and consistently used, there may be inconsistencies in the recording of infant deaths and live births. When an infant dies there are three possible classifications:

a) a live birth followed by an infant death;
b) a stillbirth;
c) no registration or classification.

Only the first of these contributes to infant mortality statistics. If an infant dies and it is registered as a stillbirth or if the birth is not recorded at all, rather than recording as a live birth followed by a death, it is not considered an infant death (Liu and Moon, 1992, Draper and Field, 2007). A range of factors may affect how infant births and deaths are recorded, with implications for infant mortality statistics.

Concerns over surveys and other measurement issues have been discussed in relation to infant mortality figures in low and middle income contexts. Although inconsistencies in recording have been identified in high income countries, these problems and their implications have rarely been considered when infant mortality figures are cited. It is therefore unclear to what extent international differences in infant mortality reflect real differences in the chance of infants dying before age 1, or the extent to which they reflect differences in recording practices between countries.

This review paper aims to examine the significance of differences in the recording of infant births and deaths for international comparisons of infant mortality, with a focus on high income countries. I first review the differences in recording between countries in terms of classification of infant deaths and registration coverage. I then consider implications of these differences for comparisons of infant mortality between countries.

Differences in recording of births and infant deaths

Data on infant deaths and births to calculate infant mortality rates are obtained from civil registration systems in high income countries. Firstly, there are considerable differences in the ways that births and deaths are classified. Secondly, there are differences in the coverage of registration systems.

Differences in the classification of births and infant deaths

There are both legal and informal differences in the definitions and registration of:

- The nominator - **infant deaths**. As the number of infant deaths is very small, slight discrepancies in reporting can have a large impact on the infant mortality (Liu and Moon, 1992).
- The denominator -**live births**. Differences in recording of live births have a small direct effect on the infant mortality rate by altering the denominator. They also have a larger indirect effect on recording of infant deaths - the infant has to have been recorded as a live birth for the death to be considered an infant death.
- **Stillbirths**, which may have an effect on the number of infant deaths and live births recorded.

Legal differences in definitions and registration

Legal definitions of what constitutes a live birth or a still birth affect the number of live births and infant deaths recorded, and their timing. Although there has been a tendency towards the use of standard definitions with the WHO International Classification of Diseases, there remain significant differences (Gourbin and Masuy-Stroobant, 1995, Kramer et al., 2002). The considerable impact that legal definitions have on infant mortality rates has been illustrated when countries have changed definitions, resulting in a large change in the infant mortality rate. For example, in the early 1990s Lithuania experienced a sudden rise in infant mortality by around 4 deaths per 1,000 live births when it adopted the WHO definition of a live birth (cited in (Gourbin and Masuy-Stroobant, 1995)).

Most countries adhere to the WHO definition of ‘signs of life’ for live births. However some countries have developed their own definitions of what constitutes signs of life. Official cut-offs for reporting live births vary (see Table A.3-1). Although in most countries (including England and Wales, the US, Sweden) all live births should be reported, some countries exclude births under 500g weight or under 22 weeks gestation (e.g. France) (EURO-PERISTAT project in collaboration with SCPE, 2008).

Some countries have an age criterion for live births which may lead to under-reporting of very early infant deaths. For example, until 1993 in France infants were only recorded as a live birth if they were alive at registration, which may be 24-48 hours after the birth. Infants who died before registration were termed a ‘false stillbirth’ (Liu and Moon, 1992), resulting in under-registration of neonatal deaths. In the Netherlands, if an infant was born before 24 weeks it had to survive for 24 hours before it was recorded as a live birth (Gourbin and Masuy-Stroobant, 1995).

Differences in the definition of stillbirths may have an indirect effect on live birth and infant death reporting. Some countries use the WHO definition (weight over 500g or gestational age 22 weeks), but many countries use later cut-offs. In Sweden the cut-off was after 28 weeks until July 2008, when it was changed to include cases after 22 weeks of pregnancy (Lennart Kohler, personal communication). In the United Kingdom the cut-off is set at 24 weeks with voluntary registration at 22 -23 weeks) (EURO-PERISTAT project in collaboration with SCPE, 2008). The legal definition of stillbirths affect the registration options available when an infant dies, so may influence informal differences between countries.

Furthermore, there are differences in the legal registration process between countries, including different time limits for registration and who is required to register births and infant deaths. These differences may influence informal differences in registration by opening or limiting classification choices made by health professionals or doctors. For example, some countries (including the UK) have two systems of registration: by the parents and notification by hospitals. This may reduce under-registration of infant deaths (Gourbin and Masuy-Stroobant, 1995).

Table A.3-1: Requirements for reporting a live birth in Europe and the US

Reporting requirement	Country
All live births	Austria, Denmark, England and Wales, Finland, Germany, Hungary, Italy, Northern Ireland, Portugal, Scotland, Slovak Republic, Spain, Sweden, United States
Live births at 12 weeks of gestation or more	Norway
Live births at 500 grams birthweight or more, and less than 500 grams if the infant survives for 24 hours	Czech Republic
Live births at 22 weeks of gestation or more, or 500 grams birthweight or more	France
All live births for civil registration, births at 500 grams birthweight or more for the national perinatal register	Ireland
Live births at 22 weeks of gestation or more, 500 grams birthweight or more if gestational age is unknown	Netherlands
Live births at 500 or more grams birthweight	Poland

SOURCE: NCHS/National Vital Statistics System for U.S. data and European Perinatal Health Report, p. 40 for European data: http://www.europeristat.com/bm.doc/european-perinatal-health-report.pdf.

Source: (MacDorman and Mathew, 2009)

Informal differences in classification of infants at the borderline of viability

Even when legal definitions and registration are similar, there is still variability in the classification of infants who die during delivery or soon after delivery (Kramer et al., 2002). The key differences seem to be among very preterm infants who are at the borderline of viability and deaths in the first 24 hours after birth. As a high proportion (25%) of infant mortality occurs in the first 24 hours of life, these differences can have considerable impacts on infant mortality rates (Gourbin and Masuy-Stroobant, 1995).

There are informal differences in reporting and recording, e.g. there may be differences in practice between hospitals or doctors (MacDorman and Mathew, 2009). For example, in 11 hospitals in one region in the UK, the proportion of births between 22-24 weeks that were recorded as a live birth varied between 26% and 54% (Draper and Field, 2007), suggesting variations in reporting.

There are a number of possible causes for these differences. Recording an infant death as a birth followed by a death, still birth or not recording has implications for the parents (e.g. maternity leave, funerals, need for registration), which may affect reporting. Recording as a stillbirth may be done to remove the burden on the parents of reporting a live birth and infant death (Draper and Field, 2007), depending on the legal registration process requirements. Live-born infants who are considered non-viable are often not registered at all when they are below the cut-off for registration of stillbirths (Gourbin and Masuy-Stroobant, 1995). As age and weight definitions for stillbirths vary internationally, this may be more prevalent in some countries than others.

'Cultural' differences in how very pre-term deliveries are managed may also play a role, for example differences in whether pre-term infants are resuscitated and taken to intensive care. A comparison of regions in the UK and France found that the excess neonatal mortality in the UK was due to a higher percentage of preterm births and a higher proportion of these preterm births being recorded as live births and taken to ICU. In the Netherlands, there are regulations prohibiting resuscitation of very preterm infants (both cited in (Draper and Field, 2007)).

We should also bear in mind the problems of estimating gestational age. The exact gestational age is often not known and different countries used different methods for calculating it (MacDorman and Mathew, 2009). Whilst the data of the last menstrual period is used to calculate gestational age in the United States, ultrasounds are used in the United Kingdom. This may affect classifications where gestational age cut-offs are used for live births and still births and contribute to variations in reporting of live births, still births and no registration.

Differences in registration coverage

Civil registration of births and deaths usually covers all citizens and permanent residents in Europe and high income countries. Non-nationals are usually excluded, but this is not always the case (EURO-PERISTAT project in collaboration with SCPE, 2008). This may be particularly important in countries where there are large numbers of people living temporarily or awaiting permanent residence. Ethnic minority groups tend to experience higher infant mortality rates (Gray et al., 2009); we would expect that non-national populations would also be more likely to experience infant deaths, so this could affect the overall national infant mortality rate.

Implications for international comparisons of infant mortality rates

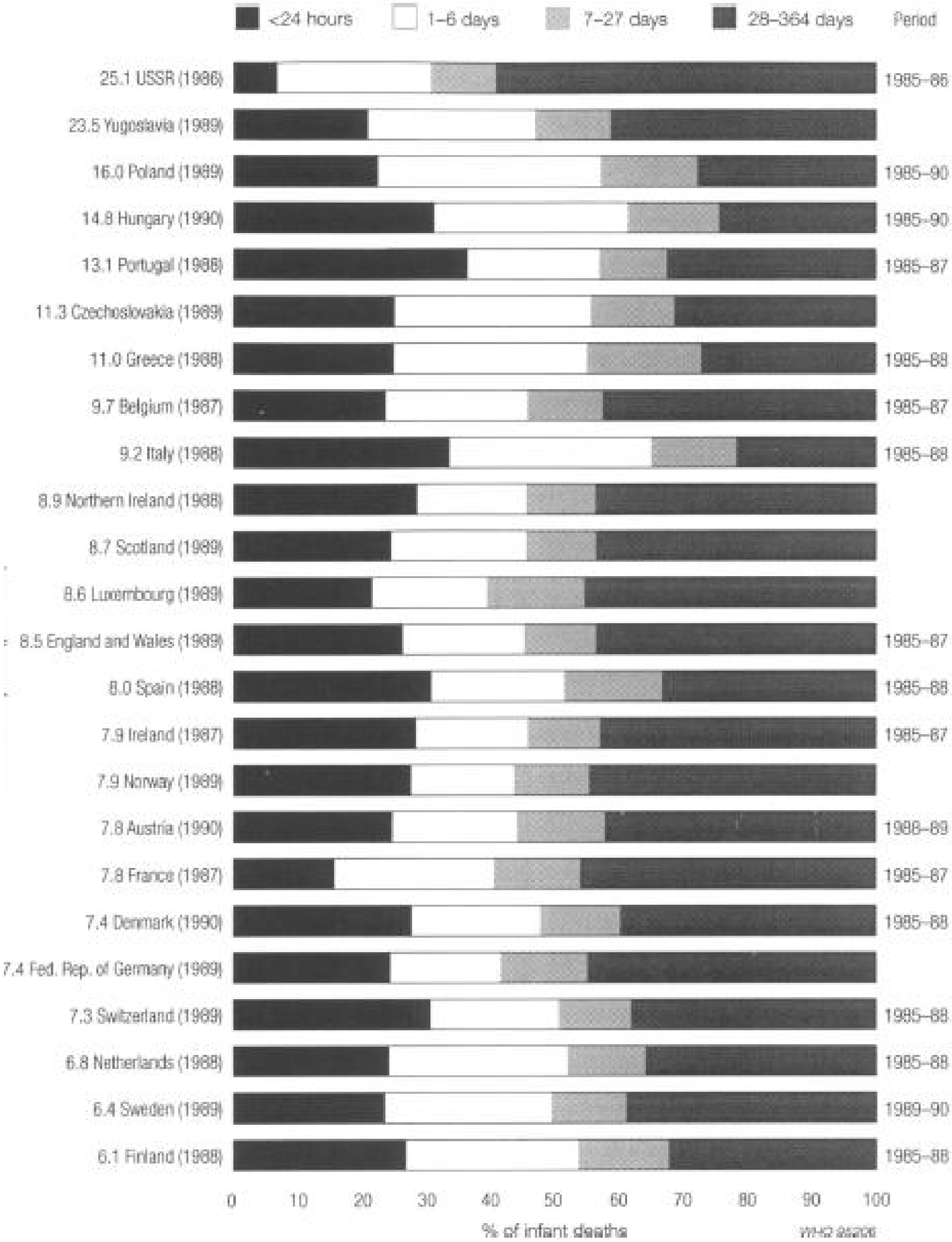
How large are the effects of these differences on comparisons of published infant mortality rates between countries? It can be difficult to investigate the effects of informal differences, in particular, as people may be unable or unwilling to disclose registration choices made. However, there have been some attempts to quantify the impact of legal and informal differences through disaggregation of data on live births and infant deaths.

Firstly, looking at data on live births, there is evidence suggesting that some countries under-report live births for infants at the borderline of viability. Kramer and colleagues found a 50-fold variation in the proportion of live births that weigh less than 500g between Sweden, Norway, Israeli Jews and non-Jews, and the white and black population in the United States in 1987-1988. They conclude that differences in risk factors are unlikely to account for this; rather there are "vast differences in registration of infants near the borderline of viability and differences in the classification of their deaths as fetal vs. infant deaths" (Kramer et al., 2002, page 20). At the time of the data collection, only still births over 28 weeks gestational age needed to be registered in Sweden. The authors suggested this provided a strong incentive for very small, preterm infants who die to be classified as still births, requiring no registration, rather than live births followed by infant deaths.

Analysis of data on infant deaths, either in the first 24 hours or among pre-term infants, when registration differences are expected to be largest, can also reveal registration differences.

Gourbin and Masuy-Stroobant disaggregated infant deaths by the timing of death (Gourbin and Masuy-Stroobant, 1995), shown in Figure A.3-2. If there are fewer infant deaths recorded in the first 24 hours than expected, it is possible that this is due to classification as stillbirths (instead of recording a live birth followed by a death). However, this could reflect also many other factors e.g. differences in the quality of care, congenital problems (and screening) etc. Figure A.3-2 shows that there is considerable variation in the proportion of infant deaths that occurred in the first 24 hours, suggesting some variation in reporting. For example, the low percentage of infant deaths in the first 24 hours in France highlights the importance of the 'false stillbirth' classification on infant death reporting.

Figure A.3-2: Proportion of infant deaths occurring in the first 24 hours in European countries, 1985-89



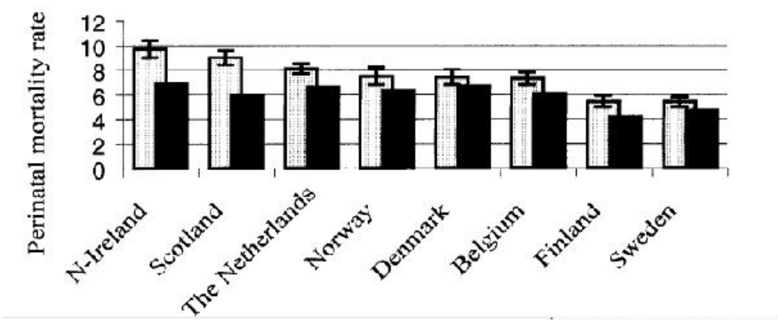
Source: (Gourbin and Masuy-Stroobant, 1995)

Data disaggregated by gestational age or birth weight can also be useful. When Kramer and colleagues re-calculated infant mortality, excluding live births weighing less than 750g to remove the registration differences of very small babies, they found that international differences in infant mortality changed considerably (Kramer et al., 2002). Gestational age-specific infant mortality rates among very pre-term infants (22-23 weeks) varied widely, from 515/1000 live births in Sweden to 1000/1000 in Scotland and Northern Ireland in 2004 (MacDorman and Mathew, 2009). This reflects differences in the quality of care, however some of the difference may be due to under-reporting of infants at the borderline of viability at early gestational ages.

Some studies have standardised infant mortality rates, in order to quantify the effects of differences in cut-offs for live and still birth reporting between countries. Graafmans and colleagues analysed the differences in definitions on perinatal mortality rates in 1994, i.e. stillbirths and infant deaths in the first week (Graafmans et al., 2001). For example, at the time, the cut-off for stillbirths was 28 weeks in Sweden, 24 weeks in England and Wales; neither country had a cut-off for live birth reporting. They directly standardised age-specific perinatal mortality rates to a standard set of reporting cut-offs, setting a lower limit for live and still birth reporting at 28 weeks gestational age/1000 grams. In other words, they removed all infant deaths under this cut-off from the analysis. Using the same cut-offs would substantially reduce variation in perinatal mortality rates. In England and Wales, perinatal mortality rates would be 63% of the published rate if a 1,000 gram cut-off were used; in Sweden this figure is 82%. Figure A.3-3 shows how the variation in perinatal mortality between countries would be reduced if a common cut-off of 28 weeks were used. However, this analysis is of perinatal mortality; differences in stillbirth definition cut-offs would have less effect on infant mortality.

Figure A.3-3: The effect of using a common cut-off at 28 weeks on perinatal mortality rates

Light bars show the published perinatal mortality rates. Dark bars show the revised perinatal mortality rates based on a live and still birth cut-off at 28 weeks gestational age (data not available on England and Wales).



Source: (Graafmans et al., 2001)

This method has also been used to aid understanding of the high infant mortality rates in the United States. MacDorman and Mathew (MacDorman and Mathew, 2009) showed that if births under 22 weeks are excluded from infant mortality figures, the US performs slightly better in international rankings. However, this is largely due to the high rate of pre-term birth in the US, and there is a danger that these analyses can overlook this problem.

Overall, differences in registration practices may have a considerable effect on published infant mortality rates, although it is difficult to isolate effects due to registration from other factors, such as health care quality.

Summary

Comparisons of infant mortality are widely used with little consideration of validity; mortality is often considered the most 'objective' indicator. But there are a number of differences in the way that infant births and deaths are recorded, which could have considerable implications for infant mortality statistics.

This review has shown the need to take more caution with international comparisons of infant mortality. International differences may reflect real differences in the risk of an infant dying in the first year of life. But they may also reflect legal differences in definitions and registration, or informal differences in practice between countries. There is increasing standardisation of legal definitions, however differences remain. The implications of these formal and informal registration differences on infant mortality statistics is difficult to quantify. Furthermore, much of the evidence also uses old data, and the effects of recent standardisation of definitions remains unclear.

Key message: International comparisons of infant mortality need to recognise the importance of differences in registration of births and infant deaths; comparisons reflect both 'real' differences in the probability of infants dying in the first year of life, and differences in the way that infant births and deaths are recorded between countries.

Appendix 4: Further information for Chapter 4

A.4.1 Studies which compared the social gradient in health using absolute measures

Table A.4-1: Studies which compared the social gradient in health using absolute measures

Reference	Countries	Data source, year, sample	Outcome measure (health/development/wellbeing)	Exposure measure		Measures of health inequality, analysis methods	Analysed role of inc inequal?
				SEP	Income inequal		
(Leon et al., 1992) Social class differences in infant mortality in Sweden: comparison with England and Wales	Sweden, England and Wales	Sweden - medical birth register 1985-6, linked to census E+W - Office of Population Censuses and Surveys, death certificate, 1983	Neonatal and postneonatal mortality	Social class (occupation) of father (British Registrar General)	None	Absolute - rates by SEP Presented tables of deaths by social class. Calculated risk ratios.	No
(Vagerö and Lundberg, 1989) Health inequalities in Britain and Sweden	Sweden, England and Wales (mortality)/Britain (illness)	Sweden – census-linked deaths registry, 1961-1979. Ages 20-65, employed at time of census. Study on living conditions, 1981. E+W – Office of Population Censuses and Surveys, 1970-72 Britain - General Household Survey	Mortality (age standardised) Long-term illness (question 'almost identical' in both countries).	Occupation (British Registrar General), education	None	Absolute – rates by SEP Calculated age-standardised death rates by SEP Logistic regression to predict long-term illness by SEP	No

Reference	Countries	Data source, year, sample	Outcome measure (health/development/wellbeing)	Exposure measure		Measures of health inequality, analysis methods	Analysed role of inc inequal?
				SEP	Income inequal		
(Wilkinson and Pickett, 2008) Income inequality and socioeconomic gradients in mortality		3139 US counties Income data from US Census 2000 Mortality from compressed mortality file, 1999-2002 Income inequality data from US Census Bureau, 1999	Mortality rates (10 causes: infant mortality, all-cause working age, all cause elderly, mortality from ischemic heart disease, respiratory disease, diabetes mellitus, breast cancer, prostate cancer, alcoholic liver disease, homicide) Age-adjusted, averaged over 4 years	Median household income at county level	Gini	Ecological analysis Single level: correlation between county mortality rates and county income (to assess steepness of gradient) Multilevel mixed effects linear regression models with random effect of state: relationship between county mortality and state income inequality, independent of county median incomes (B) Tested for cross-level interaction between state income inequality and county-level income in relation to county mortality	Yes
(Banks et al., 2006b) Disease and disadvantage in the United States and in England AND (Banks et al., 2006a) The SES gradient on both sides of the Atlantic	US and England	Men aged 40-70 (From NHNES, HSE, 1999-2003, size: 2097+5526) and 55-64 Non-Hispanic white people (from Us Health and Retirement Survey and England Longitudinal study of ageing, 2002, size: 4386 +3681)	Self-reported chronic diseases (diabetes and heart disease) Self-reported health behaviours Biomarkers as objective measures of chronic disease	Education (years of schooling; grouped to reflect qualifications) Household income (age-specific terciles, adjusted for household size)	None	Absolute – prevalence by SEP Qualitative comparisons of the steepness of the gradients Ordinary least squares regression to predict chronic diseases (as function of education and income, risk behaviours). Repeated using multiple logistic or multi-variate probit models.	No Briefly discussed income inequality

Reference	Countries	Data source, year, sample	Outcome measure (health/development/wellbeing)	Exposure measure		Measures of health inequality, analysis methods	Analysed role of inc inequal?
				SEP	Income inequal		
(Adler et al., 2008) Social status and health: A comparison of British civil servants in Whitehall-II with European and African-Americans in CARDIA	US (white and black separate), Britain	US – CARDIA, longitudinal, includes community samples and from health plan, age 33-48. YEAR Britain - Whitehall-II, longitudinal, sample from civil service, age 47-67. YEAR	Hypertension (medical exam), depression (different measures in each study, dichotomised), global health (same question, dichotomised)	Subjective social status (SSS) – (9 rungs in CARDIA, 10 in Whitehall, slightly different wording); Occupation (grade in Whitehall, SEI in CARDIA); Household income (9 categories in CARDIA, 11 categories in Whitehall); Education (6 categories in CARDIA, 5 in Whitehall)	None	Absolute - Prevalence by SEP; Single relative value - RII Present age standardised outcomes by SEP Logistic regression to test association between health outcomes and SSS, controlling for age Calculated RII (compares predicted odds ratio of outcome for those at the lowest vs. highest levels, based on predicted trend across all SSS groups (Also - regressed SSS on 2 components of objective SEP. Models including objective measures of SEP to evaluate the degree to which the relationship between SSS and health is accounted for by each type of SEP)	No
(Lahelma et al., 1994) Comparisons of inequalities in health: evidence from national surveys in Finland, Norway and Sweden	Finland, Norway, Sweden	Level of living surveys (LLS) –1986-7, non-institutionalised sample, ages 25-74	Self-reported limiting long-standing illness	Education level – 3 groups	None	Absolute – prevalence by SEP Described age-standardised prevalence of limiting long-standing illness by education level Calculated age-standardised illness ratios. Calculated concentration indices	No

Reference	Countries	Data source, year, sample	Outcome measure (health/developmen t/wellbeing)	Exposure measure		Measures of health inequality, analysis methods	Analysed role of inc inequal?
				SEP	Income inequal		
(Due et al., 2009a) Socioeconomic position, macroeconomic environment and overweight among adolescents in 35 countries	35 countries in Europe and North America	HBSC 2001-2002. N=162,305 11, 13, 15 year olds	Self-reported height and weight (calculated BMI)	Family affluence (FAS), school affluence	Gini coefficient (UNDP 2003)	Absolute - SII and Relative - RII 33 countries included in analysis Calculated age-standardised BMI prevalence Calculated prevalence difference (between lowest and highest SEP), slope index of inequality and relative index of inequality using weighted least square linear regression Linear regression to assess association between gini and SII/RII Multilevel logistic regression to assess association between macroenvironmental factors and individual-level overweight (not reported)	Yes
(Levin et al., 2010) National income and income inequality, family affluence and life satisfaction among 13 year old boys and girls: a multilevel study in 35 countries	35 countries	HBSC, 13 year olds	Life satisfaction (Cantril's ladder). Used as continuous and binary measure.	Family Affluence Scale (FAS)	Gini	Multilevel linear and logistic regression analysis 4 levels: country/region (log GDP, gini), stratum (geography or school type), class, individual (age, sex family structure, FAS). Included cross-level interaction. Test for between country slope variation – test on slope variance and intercept-slope covariance	Yes Analysed interaction between Gini and FAS

Reference	Countries	Data source, year, sample	Outcome measure (health/development/wellbeing)	Exposure measure: SEP	Exposure measure: Income inequal	Measures of health inequality, analysis methods	Analysed role of inc inequal?
(Marks, 2005) Cross-national differences and accounting for social class inequalities in education	32 countries, mostly OECD	Program for International Student Assessment (PISA), 2000, 15 year olds. Cluster sampling from schools.	Reading literacy score (standardised to international mean of 500, sd 100)	Parent's occupation (father's occupation, mother's used if father's missing) (EGP), student report.	Gini	Absolute – score by SEP Analysis methods not described Present mean reading score by SEP Present regression coefficients for each occupation in each country, R2 – methods unclear Correlation between Gini and R2.	No - Correlation between Gini and R2 (between social class and reading score). But did not analyse relationship with the slope of the gradient.
(Bradbury et al., 2010) Inequality during the early years: Child outcomes and readiness to learn in Australia, Canada, United Kingdom, and United States	Canada, US, UK, Australia	4 cohorts (MCS, LSAC, NLSCY, ECLS-B), children aged 4-5, 2004-2008? (not clear)	Cognitive outcomes (picture vocabulary tests) Socio-emotional development (hyperactivity/ inattention and conduct problems) Different tests and scales used between countries Outcomes adjusted for age, standardised using mean zero and SD one using survey weights..	Parental education (highest qualification attained by caregiver or partner co-resident with child) - recoded to 4 levels using ISCED Gross household income (average over first 3 waves of cohort, equivalised) (quintiles)	Gini (not analysed)	Absolute – gap in scores by SEP (from regression model) Correlations between log gross household income and child outcomes. Least squares regression (income and parental education as the stratifying variables), with and without other controls. Present gap between the top, middle and bottom groups (graphically). For each outcome the authors consider whether international differences are greater at the top or bottom of the SEP distribution (point out differences in top end of distribution and discuss reasons in the conclusion)	No Briefly discuss level of income inequality.

Reference	Countries	Data source, year, sample	Outcome measure (health/development/wellbeing)	Exposure measure		Measures of health inequality, analysis methods	Analysed role of inc inequal?
				SEP	Income inequal		
(OECD, 2010) PISA 2009 Results: Overcoming Social Background. Equity in Learning Opportunities and Outcomes (Volume II)	65?? Countries ? OECD plus others	PISA 2009	PISA score Reading scale – 100 points is 1 standard deviation	Socio-economic background: combination of parents' education, occupation and home possessions Standardised to mean=0, sd=1 for OECD countries	Gini	Calculated components of social gradients in each country (height, slope, strength, length, linearity), presented tables Correlation between gini and R^2 Relationship between mean reading level and level of literacy inequality (slope and strength of the gradient)	No Analysed relationship between income inequality and R^2
(OECD and Statistics Canada, 2000) Literacy in the information age	16 (exact number not clear) OECD + other countries	International Adult Literacy Survey, 1994-1998; US National Adult Literacy Survey, 1992,ages 16-25 and 26-65	Literacy proficiency scale (prose, document, quantitative scales)	Parents' education (years)	Gini	Absolute – score by SEP Presented score by parents' education (modelled – methods not clear). Countries grouped by geographic, linguistic, economic criteria. Qualitative comparison	No. Grouped countries by region/type in graphs. Grouping reflects the degree of income inequality.

Appendix 5: Further information for Chapter 5

A.5.1 Background information on the cohort datasets

The ECLS-K

The Early Childhood Longitudinal Study, Kindergarten class (ECLS-K) is a nationally representative cohort of children in school in the United States (from kindergarten into middle school). The stated applications of the cohort are: "(1) a study of achievement in the elementary and middle school years; (2) an assessment of the developmental status of children in the United States at the start of their formal schooling and at key points during elementary and middle school; (3) cross-sectional studies of the nature and quality of kindergarten programs in the United States; and (4) a study of the relationship of family, preschool, and school experiences to children's developmental status at school entry and their progress during kindergarten, elementary school, and middle school." (Tourangeau et al., 2009, page 1-4)

The ECLS consists of two cohorts – a birth cohort (ECLS-B) and the Kindergarten cohort (ECLS-K).

The ECLS-K used multistage probability sampling to select a nationally representative sample of kindergartners. The primary sampling units were counties or groups of counties, the second-stage units were public or private schools within kindergarten classes – with oversampling of private schools. Children were then sampled within schools. Further children were added to the sample in spring of the Kindergarten year and at later sweeps. Private schools and Asian and Pacific Islander children were oversampled.

Data collection for the ECLS-K commenced in 1998–99. A total of 21,260 kindergartners participated in the first year of data collection (although there was some variation in participation between sweeps and components of data collection). Data were collected in both spring and autumn in the first two years of the study (kindergarten and first grade), followed by collections in spring of 3rd, 5th and 8th grades.Data collection included interviews with parents, school principals and teachers, student records and direct child assessments, including cognitive assessments.

Source: (Tourangeau et al., 2009)

The MCS

The Millennium Cohort Study (MCS) is a large, prospective cohort that has been following up children in the United Kingdom from age 9 months. The study is a multidisciplinary survey which aims to capture the influence of early family context on child development and outcomes throughout childhood, into adolescence and subsequently through adulthood.

The initial sample was 19,517 children in 19,244 families. The children were sampled from the Child Benefit Register, clustered within electoral wards. The sampling was stratified to oversample from particular areas: disadvantaged areas, areas with high numbers of people from minority ethnic backgrounds (in England), and Scotland, Wales and Northern Ireland.

The study recruited babies born between September 2000 and August 2001 in England and Wales (with slightly later sampling in Scotland and some later recruitment). The initial wave of data collection was at 9 months, with follow up at 3 years, 5 years, 8 years and 11 years. Data were collected from main and partner respondents (usually the child's parents) using face to face interview, and child assessments. Data were collected on a range of socioeconomic, environmental, health and social factors, and health and development outcomes.

Source: (Hansen, 2012), http://www.cls.ioe.ac.uk

The LSAC-K

The Longitudinal Study of Australian Children (LSAC)) consists of two prospective cohorts. The aim of the study is: "to provide a database for a comprehensive understanding of children's development in Australia's current social, economic and cultural environment." (Australian Institute of Family Studies, 2011, page 8)

The LSAC consists of two cohorts, both commencing in 2004: a birth cohort (LSAC-B) and a cohort starting in kindergarten (LSAC-K). I used the LSAC-K in the comparative cohort study.

The K cohort children were recruited aged 4-5 years (children born March 1999 - February 2000). 50 per cent of families who were invited to take part enrolled in the study in the K cohort families. The initial sample was 4,983 children.

Children were sampled using a two-stage clustered design (postcodes, then children selected from the Medicare Australia list). Sampling was stratified by state/city statistical division to ensure proportional geographic representation. Children and their families have been followed-up every two years (ages 4-5, 6-7, 8-9, 10-11, 12-13)

Information was collected on the child health, education, and social, cognitive and emotional development, from parents, child carers, pre-school and school teachers and the children themselves. Data collection used face to face and telephone interviews with parents, children, teachers and childcare workers and direct assessments and time use diaries. There is also some linkage with external data sources – the National Childcare Accreditation Council, Medicare Australia, the Australian Bureau of Statistics and the National Assessment Program – Literacy and Numeracy (NAPLAN).

Source: (Australian Institute of Family Studies, 2011)

The NLSCY

The National Longitudinal Study of Children and Youth (NLSCY) is a study of the development and wellbeing of Canadian children from birth to early adulthood. The NLSCY commenced in 1994. It is designed "to collect information about factors influencing a child's social, emotional and behavioural development and to monitor the impact of these factors on the child's development over time" (Statistics Canada, page 11).

The NLSCY has a complex design. Main longitudinal cohorts (followed up prospectively) were supplemented with a number of extra early child development cohorts, sampled at different points in time. Additional samples were added to maintain cross sectional representation.

The NLSCY sampled from the Labour Force Survey and the Birth Registry. The sample from the Labour Force Survey reflected the survey's sampling approach - a stratified, multistage design, to select a nationally representative sample. The Birth Registry was used when a larger number of children were needed. This employed a two-stage sampling approach – first sampling geographic areas, then births within the areas.

The cohort that were recruited age 0-1 years in 1998/1999 were age 4-5 in cycle 5. 2000 children age 0 were selected from the Labour Force Survey and 8000 children age 1 were selected from the Birth Registry. Due to some overlap between the samples, some children were excluded – leaving a sample of 7,944 in this cohort at recruitment.

The study includes data collection on the children's health physical development, learning and behaviour and social environment. Data were collected from parents, teachers and child assessments and self-completion instruments.

Source: (Statistics Canada)

The QLSCD

The Québec Longitudinal Study of Child Development (QLSCD in English; ÉLDEQ in French) was set up to improve understanding of child development in Québec province in Canada (Jetté and Groseilliers, 2000). The study initially aimed to follow up children until they started school at age 5, with the specific aim to understand the development of basic skills needed for educational success. A further phase was added to the study and data collection is ongoing.

The initial sample consisted of 2,223 children (of whom 2,120 were retained for the longitudinal study). The sample was selected to be representative of children age 5 months in Quebec who were born singletons. Sampling employed a stratified 3-stage sampling design (PSUs/regions, SSUs, TSUs); the sample was selected from the birth registry. There were some exclusions from the sample: Territories were excluded (largely aboriginal people) and 16 regions were excluded. Some children were also excluded, due to delays in birth records, duration of pregnancy or sex not recorded, unrecorded preterm and late deliveries, non-French or English speaking families, or the incorrect address.

Quebec province is in the eastern side of Canada. It is a large province with rural and urban areas and the official language is French.

Data collection commenced in 1997 and 1998. Data were collected at age 5 months, then at 17 months (1 year), 29 months (2 years) , 41 months (3 years), 53 months (4 years) and 5 years in phase 1. Further data collections took place in phase 2 and are planned until age 17 in phase 3 of the study. Data were collected from the person most knowledgeable (nearly always the mother), the partner and biological father, and from child assessments. Data were collected on the social and economic environment, family, child care and child health, development and well-being. Data collection was face to face, except for the age 5 wave, which was conducted using telephone interviews.

Source: (Jetté and Groseilliers, 2000)

Gen-R

Generation-R is a prospective cohort from foetal life into young adulthood. The study aim was "to identify early environmental and genetic causes of normal and abnormal growth, development and health during fetal life, childhood and adulthood" (Jaddoe et al., 2010, page 823).

The study sampled pregnant women in Rotterdam, from a defined set of postcode areas (covering more than half the city). In total, 9,778 mothers were enrolled in the study, with 9,745 live born children. 61% of eligible children participated in the study. The majority of participants (91%)

were enrolled in pregnancy. The dataset contains siblings. The sample is very ethnically diverse - the largest ethnic groups were the Dutch, Surinamese, Turkish and Moroccan.

Rotterdam is the second largest city in the Netherlands, with a population of 600,000. It has a very ethnically diverse population.

Data were collected from mothers, fathers and children themselves. Only partners of mothers enrolled in pregnancy were asked to participate. Assessments started in pregnancy, then follow up was frequent: 3, 6, 12, 18, 24, 30, 26, 48 months (plus further child assessments). Data were collected on biological, social and environmental exposures and a range of health and development outcomes. The study includes collection of biomarkers, including from blood and urine samples, cord blood and hair.

Sources: (Jaddoe et al., 2010) http://www.generationr.nl/researchers.html

ABIS

All Babies in Southeast Sweden (ABIS) is a prospective cohort study, starting in utero. The cohort had a particular aim "to study the influence of environmental and genetic factors on the development of Type 1 Diabetes, but also other immune-mediated diseases such as allergy, astma, celiac disease, rheumatoid arthritis, IBD (Inflammatory Bowel Disease), and also cancer" (Ludvigsson et al., 2002).

All pregnant women in the study area were asked to participate (21,700 women). The initial sample was 17,055 mothers of children in southeast Sweden born between October 1997 and October 1999 (78.6% of the mothers invited took part).

Data were collected during pregnancy, then follow-ups occurred at ages 0, 1 year, 2.5-3 years, 5-6 years, 8-9 years and 11-13 years. Data were collected on social and environmental conditions and health outcomes, using questionnaires and direct assessents. The study also collected biological samples, from mother (hair and breast milk) and child (hair, urine, stool). There were also questionnaires about social and environmental factors. Participants can be linked to national databases on income.

Sources: (Ludvigsson et al., 2002), http://www.abis-studien.se/hem/english-11100423

A.5.2 Household income question wording and banding in the study cohorts

Table A.5.1: Household income question wording and income banding in the study cohorts

	ECLS-K (US)	**MCS (UK)**	**LSAC B (Australia)**	**NLSCY (Canada)**	**QLSCD (Quebec)**	**Generation-R (Netherlands)**	**ABIS (Sweden)**
Question wording	What was the total income of all persons in your household over the past year, including salaries or other earnings, interest, retirement, and so on for all household members?	This card shows incomes in weekly, monthly and annual amounts. Which of the groups on this card represents you [and your husband/wife]'s total take-home income from all these sources and earnings, after tax and other deductions. Just tell me the number beside the row that applies to your joint incomes.	Before income tax is taken out, what is your present yearly income (for you and partner combined)? (Include pensions and allowances) (before tax, superannuation or health insurance) (Parent 1 and Partner combined) (Before tax)	Could you estimate in which of the following groups your total personal income falls? (Spontaneous answer of an exact amount or from cascade question with income categories)	What is your best estimate of the total income before taxes and deductions of all household members from all sources in the past 12 months?	Please indicate the net income of your household? This income consists of your own income plus that of your partner, if you have one. We are referring here to income from work, social benefits and/or capital that you receive 'net' per month (after deduction of tax and premiums). The income of children or other persons living in your household should only be included if this income is contributed to the household (bed and board). You do not need to include your holiday bonus.	Not available
Coding categories	Continuous	Weekly, monthly or annual bands Couple household: • < £1,600 • £1,600 less £3,100 • £3,100 < £4,700 • £4,700 < £6,200 • £6,200 < £7,800 • £7,800 < £10,400 • £10,400 < £13,000 • £13,000 < £15,600 • £15,600 < £18,200 • £18,200 < £20,800	All households (weekly) • negative income (loss) • $1-$49 • $50-$99 • $200-$299 • $100-$199 • $300-$399 • $400-$499 • $500-$599 • $600-$699	Continuous	Annual bands: • de 10000$/an • Entre 10K-14999$ • Entre 15K-19999$ • Entre 20K-29999$ • Entre 30K-39999$ • Entre 40K-49999$ • Entre 50K-59999$ • Entre 60K-79999$ • 80000$ ou +	All households (monthly) Less than € 800 € 800-1200 € 1200-1600 € 1600-2000 € 2000-2400 € 2400-2800 € 2800-3200 € 3200-4000 € 4000-4800 € 4800-5600 More than € 5600	

	ECLS-K (US)	MCS (UK)	LSAC B (Australia)	NLSCY (Canada)	QLSCD (Quebec)	Generation-R (Netherlands)	ABIS (Sweden)
Coding categories (cont.)		• £20,800 < £26,000 • £26,000 < £31,200 • £31,200 < £36,400 • £36,400 < £41,600 • £41,600 < £46,800 • £46,800 < £52,000 • £52,000 < £80,000 • £80,000 or more Lone parents: • < £1,050 • £1,050 < £2,100 • £2,100 < £3,100 • £3,100 < £4,200 • £4,200 < £5,200 • £5,200 < £7,000 • £7,000 < £8,600 • £8,600 < £10,400 • £10,400 < £12,200 • £12,200 < £13,800 • £13,800 < £17,400 • £17,400 < £20,800 • £20,800 < £24,200 • £24,200 < £27,800 • £27,800 < £31,200 • £31,200 < £34,600 • £34,600 < £52,000 • £52,000 or more	• $700-$799 • $800-$999 • $1000-$1499 • $1500-$1999 • $2000-$2199 • $2200-$2399 • $2400 or more				

Note: all questions and bands are for the sweep of data collection used in the comparative cohort study

A.5.3 Interval regression – background information

I used interval regression to convert income bands to a continuous income value. Interval regression fits a model with two dependent variables: lower bound of interval, upper bound of interval as a function of independent variables.

The dependent variables were the lower and upper bounds of the income bands. In cases where data were right-censored (e.g. $80,000 or more), the value of the upper bound was set to missing. Conversely, the value of the lower bound was set to missing for left-censored data.

I used the independent variables suggested in the MCS user guide for sweep 3 (Hansen and Joshi, 2008). These had been found to predict household income. In the ELDEQ, LSAC, Gen-R I developed variables with similar meanings to use as independent variables. There were many differences in the way that these variables were defined and coded. However, they were significant in the model so could be used to distribute income values.

The interval regression models were used to predict an income value within the income band. All predicted household incomes therefore fell within their original income band; households with characteristics associated with higher income (e.g. high education, both parents employed) were assigned values higher in the band than households with characteristics associated with lower income (e.g. low income, unemployed lone parent). The models for each cohort are shown in Tables A.5-2 to A.5-5.

Figure A.5-6 shows the distribution of income bands in each cohort before interval regression was conducted, and the distribution of continuous income using the predicted income from interval regression.

Table A.5.2: Interval regression models in the MCS

Variable	Coefficient	Std. Err.	P>z
Main respondent age	0.02	0.00	0.00
Sampling stratum (baseline: England - advantaged)			
England - disadvantaged	-0.13	0.01	0.00
England - ethnic	-0.17	0.03	0.00
Wales - advantaged	0.08	0.06	0.19
Wales - disadvantaged	0.00	0.06	0.94
Scotland - advantaged	0.06	0.07	0.36
Scotland - disadvantaged	-0.04	0.07	0.61
Northern Ireland - advantaged	0.03	0.11	0.78
Northern Ireland - disadvantaged	-0.12	0.11	0.27
Main respondent education level (NVQ) (baseline: none of these)			
level 1	0.03	0.02	0.19
level 2	0.11	0.02	0.00
level 3	0.18	0.02	0.00
level 4	0.38	0.02	0.00
level 5	0.45	0.03	0.00
overseas qualification	0.04	0.04	0.39
Main/partner labour market status (baseline: both in work or on leave)			
Main in work, partner not	-0.44	0.04	0.00
Partner in work, main not	-0.14	0.01	0.00
Both not in work	-0.66	0.03	0.00
Main in work, no partner	-0.54	0.02	0.00
Main not in work	-0.90	0.02	0.00
Unknown	-0.52	0.27	0.05
Main respondent's ethnic group (baseline: white)			
Mixed	0.00	0.11	1.00
Pakistani and bangladeshi	-0.33	0.31	0.28
Black or black Bristish	0.00	0.18	1.00
Other	-0.27	0.12	0.03
Administrative region (baseline: north east)			
North west	-0.03	0.03	0.38
Yorkshire and Humber	-0.01	0.03	0.72
East midlands	0.02	0.04	0.66
West midlands	0.04	0.03	0.28
East of England	0.10	0.03	0.00
London	0.30	0.04	0.00
South east	0.14	0.03	0.00
South west	-0.04	0.03	0.24
Wales	-0.11	0.06	0.08
Scotland	-0.02	0.07	0.81
Northern ireland	-0.02	0.11	0.88
Accommodation (baseline: house or bungalow)			
Flat or maisonette	-0.22	0.02	0.00
Studio flat	0.04	0.27	0.87
Room or bedsit	-0.14	0.27	0.61

Observation summary:
Number of observations: 11288
32 left-censored observations
0 uncensored observations
396 right-censored observations
10860 interval observations

Table A.5.3: Interval regression model in the QLSCD

Variable	Coefficient	Std. Err.	P>z
Mother age	0.01	0.00	0.00
Residence sector type (baseline: Montreal)			
Other metropolitan	-0.10	0.03	0.00
Area with >10,000 inhabitatnts	-0.17	0.04	0.00
Rural	-0.23	0.03	0.00
Parental employment (baseline: 2 parents, both in work)			
2 parents, 1 in work	-0.26	0.03	0.00
2 parents, 0 in work	-0.80	0.11	0.00
1 parent, in work	-0.59	0.04	0.00
1 parent, not in work	-0.96	0.07	0.00
Mother's highest educational qualification (baseline: no secondary school diploma)			
Secondary school diploma	0.15	0.05	0.00
Post secondary studies	0.13	0.04	0.00
Professional diploma	0.14	0.04	0.00
College diploma	0.31	0.04	0.00
Partial university study	0.27	0.06	0.00
University diploma	0.56	0.04	0.00
Does not own house (baseline: own house)	-0.33	0.03	0.00
Mother's ethnicity (baseline: Canadian)			
French	0.00	0.03	0.92
British	-0.12	0.05	0.01
European	-0.17	0.05	0.00
Amerindian	-0.18	0.07	0.01
Other	-0.10	0.05	0.05
(African or Haitian was excluded from the model)			

Observation summary:
Number of observations: 1531
5 left-censored observations
0 uncensored observations
455 right-censored observations
1071 interval observations

Table A.5.4: Interval regression model in the LSAC-K
(continued on next page)

Variable	Coefficient	Std.Err	p-value
Main respondent age	0.01	0.00	0.00
Sampling stratum (baseline: nsw met)			
nsw xmet large	-0.19	0.03	0.00
nsw xmet small	-0.30	0.07	0.00
vic met large	-0.15	0.12	0.21
vic met small	-0.17	0.17	0.32
vic xmet large	-0.34	0.12	0.00
vic xmet small	-0.42	0.12	0.00
qld met	-0.28	0.09	0.00
qld xmet large	-0.39	0.09	0.00
qld xmet small	-0.44	0.10	0.00
sa met large	-0.28	0.11	0.01
sa xmet large	-0.17	0.13	0.19
sa xmet small	-0.23	0.16	0.14
wa met large	-0.29	0.14	0.05
wa met small	-0.36	0.18	0.05
wa xmet large	-0.23	0.15	0.13
wa xmet small	-0.47	0.16	0.00
tas met	-0.52	0.25	0.04
tas xmet	-0.69	0.25	0.01
nt met	-0.27	0.21	0.19
nt xmet large	-0.28	0.20	0.17
act	-0.40	0.18	0.02
Main respondent education level (baseline: below secondary)			
Secondary	0.06	0.02	0.01
Post-secondary/technical	0.07	0.03	0.01
Degree or higher	0.31	0.02	0.00
Main/partner labour market status (baseline: 2 parents, both employed)			
2 parents, 1 employed, 1 not working	-0.19	0.02	0.00
2 parents, both not working	-0.84	0.04	0.00
1 parent, employed	-0.75	0.03	0.00
1 parent, not working	-1.08	0.03	0.00
Main respondent region of birth (baseline: Australia/New Zealand)			
Europe and central Asia	0.01	0.03	0.67
North America	0.15	0.09	0.10
Latin America and Caribbean	0.19	0.20	0.34
Middle East and north Africa	-0.52	0.44	0.23
Africa	0.13	0.13	0.33
South Asia	-0.05	0.15	0.77
East Asia and pacific	-0.16	0.06	0.01
State (baseline: nsw)			
vic	0.02	0.11	0.88
qld	0.14	0.09	0.12
sa	0.07	0.11	0.56
wa	0.14	0.14	0.33
tas	0.35	0.24	0.15
nt	0.26	0.19	0.19

act	0.43	0.18	0.02
Accommodation type (baseline: house)			
Flat	-0.09	0.05	0.06
Caravan/cabin	-0.23	0.10	0.02
Farm	-0.31	0.05	0.00
Other	-0.09	0.09	0.29

Observation summary:
Number of observations: 3868
0 left-censored observations
3 uncensored observations
378 right-censored observations
3487 interval observations

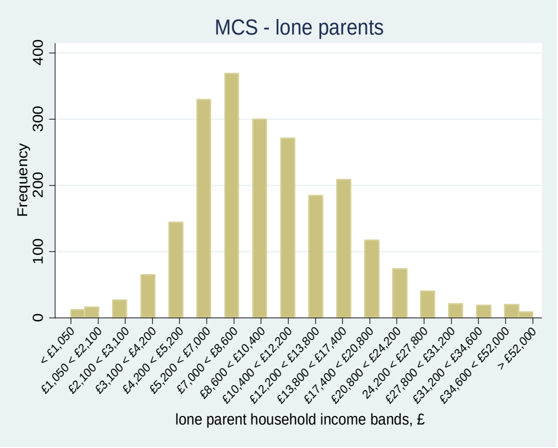
Table A.5.5: Interval regression model in Gen-R

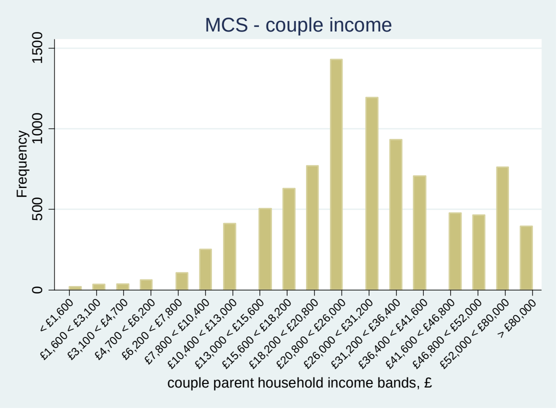
Variable		Coefficient	Std.Err	p-value
Mother's age		0.02	0.00	0.00
Postcode (grouped by area in Rotterdam)				
	2	-0.15	0.03	0.00
	3	-0.10	0.06	0.08
	4	-0.16	0.02	0.00
	5	-0.01	0.02	0.69
	6	-0.04	0.07	0.52
	7	0.02	0.02	0.51
	8	0.11	0.03	0.00
	9	0.04	0.02	0.07
Mother's education level				
	1	-0.16	0.37	0.67
	2	-0.01	0.36	0.98
	3	0.12	0.36	0.74
	4	0.27	0.36	0.45
	5	0.54	0.36	0.13
	6	0.52	0.37	0.16
Main/partner labour market status (baseline: 2 parents, both employed)				
2 parents, 1 employed, 1 not working		-0.15	0.02	0.00
2 parents, both not working		-0.65	0.09	0.00
1 parent, employed		-0.67	0.03	0.00
1 parent, not working		-0.85	0.05	0.00
Unknown		-0.32	0.03	0.00
Mother's ethnicity				
	2	0.02	0.04	0.67
	3	-0.03	0.04	0.40
	4	0.00	0.12	0.99
	5	0.01	0.03	0.78
	6	0.10	0.12	0.37

Observation summary:
Number of observations: 3191
12 left-censored observations
0 uncensored observations
546 right-censored observations
2633 interval observations

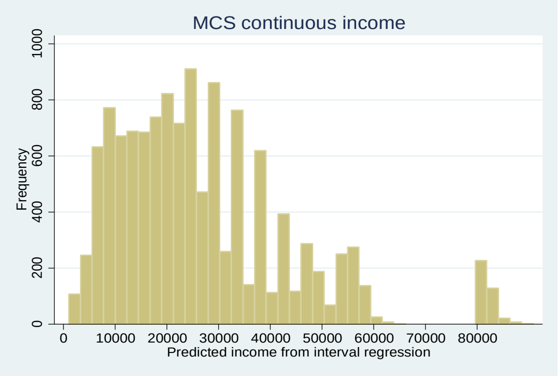
Table A.5-6: Distribution of a) income bands before interval regression and b) continuous income after interval regression

a) MCS income bands (before)

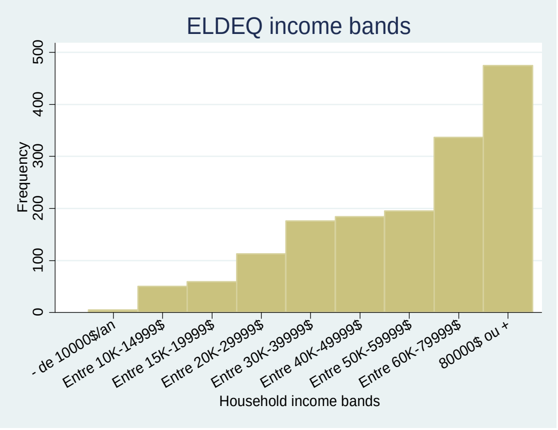




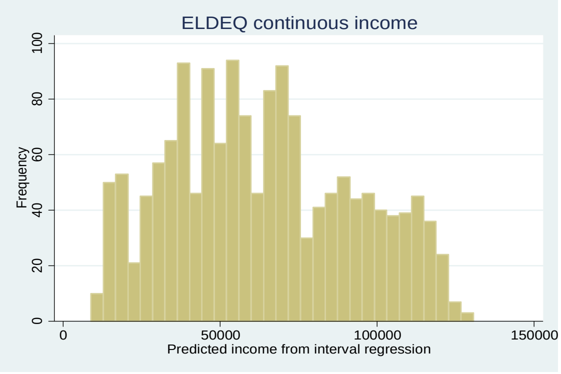
b) MCS continuous income (after)



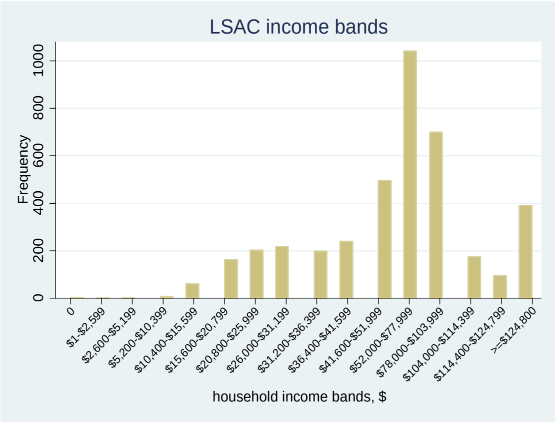
a) QLSCD income bands (before)



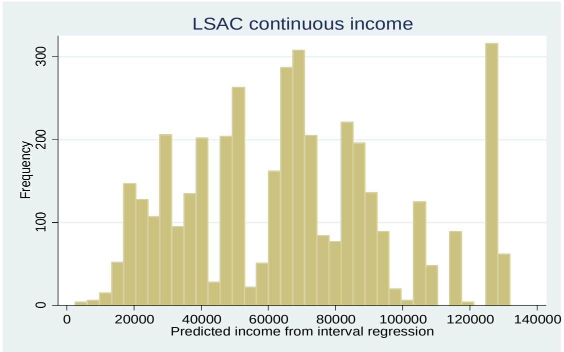
b) QLSCD continuous income (after)



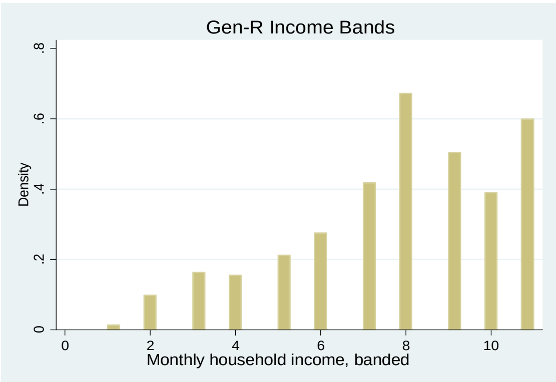
a) LSAC-K income bands (before)



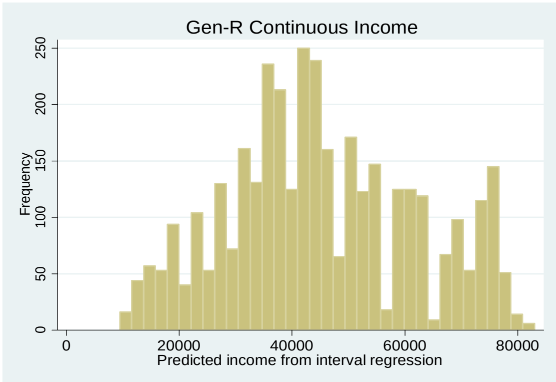
b) LSAC-K continuous income (after)



a) Gen-R income bands (before)



b) Gen-R continuous income (after)



A.5.4 Parental education recoding strategy

Table A.5-8: Parental education categories – recoding decisions for cohorts

Cat.	ECLS-K (US)	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Quebec)	Gen-R (Netherlands)	ABIS (Sweden)
1	8th grade or below 9th-12th grade	Academic qualification either of: • CSE below grade 1/GCSE or O Level below grade C, SCE Standard, • Ordinary grades below grade 3 or Junior Certificate below grade C Or vocational qualification any of: • NVQ or SVQ Level 1/GNVQ Foundation Level or GSVQ Level 1 • BTEC, SCOTVEC first or general certificate/SCOTVEC modules • City & Guilds part 1/RSA Stage I,II,III/Junior certificate	Years of schooling <= year 10 AND highest qualification = has no certificate	No secondary school diploma	No secondary school diploma	No primary school completed Primary school completed (elementary education) Special/remedial primary education (ZMOK, MLK, ZMLK, BLO, LOM) *d.* Special secondary education (VSO-LOM, VSO-MLK) Pre-vocational education (VBO)	Grundskola (elementary/ secondary school)
2	High school diploma/equivalent	Academic qualification either of: • A/AS/S Levels/SCE Higher, Scottish Certificate Sixth Year Studies, • Leaving Certificate or equivalent • Level or GCSE grade A-C, SCE Standard, Ordinary grades 1-3 or • Junior Certificate grade A-C Or vocational qualification any of: • NVQ or SVQ Level 3/GNVQ Advanced or GSVQ Level 3 • OND, ONCM BTEC National, SCOTVEC National	Years of schooling >= year 10 AND highest qualification = has a certificate	Secondary school diploma	Secondary school diploma	.Lower vocational education / secondary general education (VMBO, MAVO, MULO) General secondary education (HAVO, VWO, HBS, MMS, lyceum, atheneum, gymnasium)	Gymnasium, praktisk linje (senior high school – practical)

		Certificate • City & Guilds advanced craft, Part III/RSA Advanced Diploma • NVQ or SVQ Level 2/GNVQ Intermediate or GSVQ Level 2 • BTEC, SCOTVEC first or general diploma • City & Guilds Craft or Part II/RSA Diploma					
3	Vocational/technical programme Some college Graduate/professional school – no degree	Academic qualification either of: • Post-graduate Diplomas and Certificates • Diplomas in higher education and other higher education qualifications • Teaching qualifications for schools or further education (below degree level) Or vocational qualification any of: • Nursing or other medical qualifications (below degree level) • NVQ or SVQ level 4 or 5 • HND, HNC, Higher Level BTEC/RSA Higher Diploma	Has trade qualification or highest qualification = advanced diploma/diploma	Post-secondary diploma (excluding university)	Post-secondary diploma (excluding university)	Senior secondary vocational education (MBO, apprenticeship training) Higher professional education (HBO	Gymnasium, teoretisk linje (senior high school - theoretical Folkhögskola (residential college)
4	Bachelor's degree Masters degree Doctorate/professional degree	Academic qualification either of: • Higher Degree and Postgraduate qualifications • First Degree (including B.Ed.) Or vocational qualification any of: • Professional qualifications at degree level e.g. graduate member of professional institute, chartered accountant or surveyor	Highest qualification = bachelor degree or graduate diploma/certificate or postgraduate degree	University diploma	University diploma	University degree (WO)	Högskolautbildning högskole/univ-utbildning (college/university)

Appendix 6: Further information for Chapter 6

A.6.1 Descriptive statistics – additional tables of unweighted and weighted statistics

In this section, all NLSCY figures have been rounded according to Statistics Canada regulations. Means and proportions have been rounded to 1 decimal place.

Table A.6-1: Age and Sex of samples descriptive statistics

	Group A				Group B						Group C			
	ECLS-K (US)		MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)		QLSCD (Canada)		Gen-R (Neth)		ABIS (Sweden)	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Age (months)														
mean	68.8	68.8	62.8	62.6	56.9	57.0	-	58.2	61.8	61.7	72.6	-	64.5	-
sd	4.33	4.28	3.00	2.91	2.62	2.63	-	4.1	3.08	3.08	3.3	-	3.5	-
range	54.0-79.0		53.0-73.7		51.0-67.0			48->=65	56.0-68.0		58.2-84.0	-	54-78	-
Sex														
girls	49%	48%	49%	49%	49%	48%	-	49%	51%	51%	50.6%	-	47.5%	-
boys	51%	52%	51%	51%	51%	52%	-	51%	49%	49%	49.4%	-	52.5%	-

Table A.6-2: Household structure descriptive statistics

	Group A				Group B						Group C			
	ECLS-K (US)		MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)		QLSCD (Canada)		Gen-R (Neth)		ABIS (Sweden)	
	Un-weighted	Weighted	Un-weighted	Weighted	Un-weighted	Weighted	Un-weighted	Weighted	Un-weighted	Weighted	Unweighted	Weighted	Unweighted	Weighted
Number of adults													**Lone/couple parent**	
1	10.5%	10.9%	16.7%	16.5%	10.4%	11.0%	-	12.9%	12.3%	13.3%	13.2%	-	Lone: 6.6%	-
2	81.0%	80.2%	77.9%	78.2%	79.0%	77.7%	-	81.8%	79.3%	77.7%	85.3%	-	Partner: 3.4%	-
3	6.4%	6.7%	4.5%	4.4%	7.1%	7.6%	-	3.5%	6.1%	6.6%	1.2%	-		-
4+	2.1%	2.1%	1.0%	0.9%	3.5%	3.8%	-	1.8%	2.3%	2.5%	3.3%	-		-
Number of children							-						**Number of siblings**	
1	15.3%	15.5%	17.5%	17.0%	12.5%	12.6%	-	18.1%	17.3%	18.1%	19.0%	-	0: 6.5%	-
2	47.2%	47.3%	49.5%	50.7%	51.2%	50.7%	-	53.5%	56.8%	56.1%	56.2%	-	1: 56.3%	-
3	26.5%	26.3%	22.9%	22.6%	26.5%	26.6%	-	20.6%	20.7%	20.3%	21.4%	-	2: 26.1%	-
4+	11.0%	10.9%	10.2%	9.8%	9.5%	10.0%	-	7.8%	5.2%	5.5%	3.4%	-	3: 11.1%	-

Table A.6-3: Parental education descriptive statistics (highest parental education level)

Highest parental education	Group A				Group B						Group C			
	ECLS-K (US)		MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)		QLSCD (Canada)		Gen-R (Neth)		ABIS (Sweden)	
	Un-weighted	Weighted	Un-weighted	Weighted	Un-weighted	Weighted	Un-weighted	Weighted	Un-weighted	Weighted	Un-weighted	Weighted	Un-weighted	Weighted
1 (lowest)	3.2%	3.8%	14.5%	13.7%	6.6%	8.1%	-	7.9%	8.2%	9.9%	4.8%	-	2.0%	-
2	21.8%	23.5%	42.6%	42.3%	24.7%	25.6%	-	17.3%	15.5%	16.7%	21.1%	-	18.9%	-
3	37.0%	36.9%	11.0%	11.1%	32.5%	34.4%	-	42.8%	39.3%	39.0%	25.8%	-	31.6%	-
4 (highest)	38.0%	35.9%	31.9%	32.9%	36.2%	31.9%	-	32.0%	37.0%	34.4%	48.4%	-	47.5%	-

Table A.6-4: Household income descriptive statistics

	Group A				Group B						Group C		
	ECLS-K (US)		MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)		QLSCD (Canada)		Gen-R (Neth)		ABIS
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	
Income (local currency)	US$, 1999		GB£, 2005		Aus$, 2004		Can$, 2003		Can$, 2003		Euros, 2010		
mean (se)	61,150	59,340 (454)	26,851	27,894 (186)	66,058	64,099 (508)	-	70,400 (800)	63,625	61,166 (790)	45,315	-	
sd	41,733	41,205	16,834	17,450	32,258	31,626	-	41,000	29,075	29,151	16,775	-	Not available
median	50,000	50,000	23,691	24,296	63,183	62,077	-	63,700	61,172	57,308	43,460	-	
range	0-200,000		1,050-90,887		2,599-149,213		-	-	8,864-130,699		9,497-83,026		
Income (2005 PPP$)													
mean (se)	71,692	69,570 (532)	40,259	41,823 (279)	46,332	44,958 (356)	-	58,100 (700)	52,573	50,541 (653)	46,172	-	
sd	48,928	48,309	25,241	26,163	22,625	22,182	-	33,900	24,024	24,087	17,092	-	
median	58,620	58,620	35,522	36,428	44,315	43,540	-	52,600	50,546	47,353	44,281	-	
range	0-234,479		1,574-136,272		1,823-104,655		-	-	7,325-107,995		9,676-84,596		
Equivalised income (2005 PPP$)													
mean (se)	34,715	33,722 (256)	19,844	20,609 (135)	22,365	21,674 (174)	-	28,700 (300)	52,573	25,097 (323)	23,449	-	
sd	23,533	23,247	12,310	12,703	11,098	10,851	-	16,400	24,024	11,947	8,395	-	
median	29,310	29,106	17,464	18,015	21,015	20,320	-	25,600	50,546	23,696	22,640	-	
range	0-165,802		643-77,937		911-61,895		-	-	3,662-62,351		4,365-57,475		

Table A.6-5: Child height descriptive statistics

	Group A				Group B				Group C			
	ECLS-K (US)		MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)	QLSCD (Canada)	Gen-R (Neth)		ABIS (Sweden)	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted			Unweighted	Weighted	Unweighted	Weighted
Height (cm)												
Total sample							Excluded	Excluded				
mean	113.7	113.6	110.5	110.6	108.5	108.5			118.9	-	114.1	-
sd	5.5	5.4	4.9	4.9	4.7	4.7			5.2	-	5.2	-
range	88.9-152.4		89.9-131.0		93.0-125.5				101.3-136.7		95.0-140.0	
Girls												
mean	113.1	113.0	110.0	110.1	108.0	108.0			118.5	-	113.6	-
sd	5.4	5.4	4.9	4.9	4.6	4.6			5.3	-	5.1	-
range	92.9-152.4		89.9-127.5		93.0-125.5				101.3-136.7		97.0-140.0	
Boys												
mean	114.3	114.2	111.0	111.0	109.0	109.0			119.2	-	114.5	-
sd	5.4	5.4	4.9	4.9	4.7	4.7			5.2	-	5.2	-
range	88.9-136.5		91.0-131.0		93.0-125.5				101.9-135.9		95.0-140.0	

Table A.6-6: Obesity/overweight descriptive statistics

	Group A				Group B				Group C			
	ECLS-K (US)		MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)	QLSCD (Canada)	Gen-R (Neth)		ABIS (Sweden)	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted			Unweighted	Weighted	Unweighted	Weighted
% overweight/ obese												
Total sample	18.2%	18.3%	21.6%	20.7%	20.5%	20.5%	Excluded	Excluded	12.4%	-	16.9%	-
Girls	19.7%	19.3%	24.0%	23.0%	22.9%	22.7%			15.0%	-	19.3%	-
Boys	16.8%	17.4%	19.3%	18.5%	18.3%	18.4%			9.8%	-	14.8%	-

Table A.6-7: Excellent general health descriptive statistics

% with excellent health	Group A				Group B						Group C		
	ECLS-K (US)		MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)		QLSCD (Canada)		Gen-R (Neth)	ABIS (Sweden)	
	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted		Unweighted	Weighted
Total sample	58	57.0%	54.2%	53.9%	58.4%	58.0%	-	63.3%	56.6%	55.3%	Not available	21.1%	-
Girls	59.2%	58.1%	56.2%	55.3%	60.5%	59.8%	-	66.4%	56.1%	54.8%		17.9%	-
Boys	56.3%	55.9%	52.4%	52.5%	56.4%	56.2%	-	60.4%	57.1%	55.9%		23.9%	-

Table A.6-8: Chronic illness descriptive statistics

% with chronic illness	Group A			Group B						Group C		
	ECLS-K (US)	MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)		QLSCD (Canada)		Gen-R (Neth)	ABIS (Sweden)	
		Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted		Unweighted	Weighted
Total sample	Not available	20.1%	19.9%	21.1%	21.7%	-	20	25	25	Not available	21.1%	-
Girls		17.5%	17.5%	17.2%	17.9%	-	18	22	23		17.9%	-
Boys		22.5%	22.2%	24.9%	25.3%	-	22	28	28		23.9%	-

Table A.6-9: Emotional problems and anxiety score descriptive statistics

	Group A		Group B			Group C	
	ECLS-K (US)	MCS (UK)	LSAC-K (Australia)	NLSCY (Canada)	QLSCD (Canada)	Gen-R (Neth)	ABIS (Sweden)

Emotional problems and anxiety		Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	
Raw scores												
Total sample												
mean	Not	1.3	1.3	1.6	1.7		2.0	2.7	2.7	1.6	-	Not
sd	available	1.5	1.5	1.6	1.6		1.7	1.8	1.8	1.9	-	available
range		1-10		0-9			-	0-10		0-14	-	
Girls												
mean		1.4	1.4	1.6	1.7		2.0	2.7	2.8	1.6	-	
sd		1.5	1.6	1.6	1.7		1.7	1.7	1.7	1.9	-	
Boys												
mean		1.4	1.4	1.6	1.7		2.0	2.7	2.7	1.6	-	
sd		1.5	1.6	1.6	1.6		1.7	1.8	1.8	2.0	-	
Standardised												
Total sample												
mean	Not		0.00		0.00		0.0		0.00	0.00	-	
sd	available		1.00		1.00		1.0		1.00	1.00	-	
range		-0.86-5.63		-1.02-4.44			-	-1.55-4.14		-0.83-6.44	-	
Girls												
mean			0.03		0.00		0.0		0.02	0.00	-	
sd			1.01		1.01		1.0		0.98	0.98	-	
Boys												
mean			-0.03		0.00		0.0		-0.02	0.00	-	
sd			0.99		0.99		1.0		1.02	1.02	-	

Table A.6-10: Hyperactivity and inattention score descriptive statistics

Hyperactivity and inattention	Group A			Group B						Grpup C		
	ECLS-K (US)	MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)		QLSCD (Canada)		Gen-R (Neth)		ABIS (Sweden)
		Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted
Raw scores												
Total sample												
mean	Not	3.3	3.3	3.5	3.6		2.9	3.6	3.7	2.9	-	Not
sd	available	2.4	2.4	2.3	2.3		2.1	2.1	2.1	2.5	-	available
range		0-10		0-10				0-10		0-12	-	
Girls												
mean		2.9	2.9	3.1	3.2		2.6	5.3	5.4	2.6	-	
sd		2.3	2.3	2.2	2.2		1.9	2.0	2.0	2.3	-	
Boys												
mean		3.6	3.6	3.9	4.0		3.2	4.0	4.0	3.2	-	
sd		2.5	2.5	2.4	2.4		2.1	2.2	2.2	2.6	-	
Standardised												
Total sample												
mean	Not		0.00		0.00		0.0		0.00	0.00	-	Not
sd	available		1.00		1.00		1.0		1.00	1.00	-	available
range			-1.37-2.82		-1.56-2.78		-		-1.71-2.96	-1.16-3.62	-	
Girls												
mean			-0.15		-0.18		-0.1		-0.14	-0.11	-	
sd			0.95		0.94		0.9		0.94	0.93	-	
Boys												
mean			0.14		0.17		0.1		0.14	0.11	-	
sd			1.03		1.02		1.0		1.04	1.05	-	

Table A.6-11: Verbal cognition descriptive statistics

	Group A			Group B					Group C	
	ECLS-K (US)	MCS (UK)		LSAC-K (Australia)		NLSCY (Canada)		QLSCD (Canada)	Gen-R (Neth)	ABIS (Sweden)
Verbal cognition	Unweighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Weighted	Unweighted	Unweighted	Unweighted
Raw scores										
Total sample										
mean	Not	109.7	110.1	64.7	64.5	-	60.3	Not	Not	Not
sd	available	14.8	14.7	5.9	5.9	-	18.0	available	available	available
range		10.0-170.0		30.6-84.8		-				
Girls										
mean		110.1	110.6	65.1	64.9	-	62.0			
sd		14.4	14.0	6.0	5.9	-	17.3			
Boys										
mean		109.4	109.6	64.3	64.1	-	58.8			
sd		15.2	15.3	5.8	5.9	-	18.4			
Standardised										
Total sample										
mean	Not		0.00		0.00	-	0.0	Not	Not	Not
sd	available		1.00		1.00	-	1.0	available	available	available
range		-6.81-4.08		-5.73-4.43						
Girls										
mean			0.03		0.07	-	0.0			
sd			0.95		1.01	-	1.0			
Boys										
mean			-0.03		-0.07	-	-0.1			
sd			1.04		0.99	-	1.0			

A.6.2 Missing Data Analysis

Table A.6-12: Missing data

	ECLS-K			MCS			LSAC-K			NLSCY		
	Number missing	**% of sample missing**	**Mean income (PPP$) if missing**	**Number missing**	**% of sample missing**	**Mean income (PPP$) if missing**	**Number missing**	**% of sample missing**	**Mean income (PPP$) if missing**	**Number missing**	**% of sample missing**	**Mean income (PPP$) if missing**
Household income (equivalised)	0	0.0%	N/A	162	1.3%	N/A	140	3.3%	N/A	0	0.0%	N/A
Parental education	0	0.0%	N/A	175	1.4%	32814.4	20	0.5%	*	0	0.0%	N/A
Height	212	2.2%	60423.8	167	1.3%	29281.6	33	0.8%	35,529	-	-	-
Overweight/obesity	216	2.3%	60124.4	178	1.4%	30450.2	40	0.9%	34,970	-	-	-
General health	6	0.1%	57838.2	43	0.3%	22187.8	1	0.0%	12,950	33	0.6%	**
Chronic illness	-	-	-	49	0.4%	24626.6	0	0.0%		32	0.6%	**
Hyperactivity/ inattention	-	-	-	150	1.2%	24461.2	6	0.1%	37,934	32	0.6%	**
Emotional/ anxiety problems	-	-	-	173	1.4%	23470.7	7	0.2%	35,179	0	0.0%	N/A
Verbal cognition	-	-	-	191	1.5%	29561.2	448	10.6%	44,841	435	8.3%	**
Total sample size	*9,495*			*12,523*			*4,243*			*5,267*		
Total sample income			*71,692*			*40,259*			*46,332*			-

	QLSCD			Gen-R			ABIS		

	Number missing	% of sample missing	Mean income (PPP$) if missing	Number missing	% of sample missing	Mean income (PPP$) if missing	Number missing	% of sample missing	Mean income (PPP$) if missing
Household income (equivalised)	63	3.9%	N/A	315	6.0%		-	-	-
Parental education	0	0.0%	N/A	112	2.1%	41,037	65	4.0%	-
Height	-	-	-	8	0.2%	48,087	143	8.9%	-
Overweight/obesity	-	-	-	8	0.2%	48,087	669	41.5%	-
General health	0	0.0%	N/A	621	11.8%	40,560	-	-	-
Chronic illness	0	0.0%	N/A	-	-		0	0.0%	-
Hyperactivity/ inattention	0	0.0%	N/A	265	5.0%	40,332	-	-	-
Emotional/ anxiety problems	0	0.0%	N/A	267	5.1%	40,358	-	-	-
Verbal cognition	-	-	-	-	-		-	-	-
Total sample size	*1,612*			*3,632*			*7,170*		
Total sample income			*52,573*			*46,172*			*Not available*

*income data also missing

**unweighted figures were not released for reporting

Appendix 7: Further information for Chapter 7

A.7.1 Unadjusted socioeconomic gradients – additional tables of weighted and unweighted figures

In this section, all NLSCY figures have been rounded according to Statistics Canada regulations. Estimates have been rounded to the nearest 100; means and proportions have been rounded to 1 decimal place.

Table A.7-1: Height – unadjusted parental education gradients

	Group A						Group B			Group C					
	ECLS-K (US)			MCS (UK)			LSAC-K (Australia)			ABIS (Sweden)			Gen-R (Netherlands)		
Parental education	Unweighted n	Unweighted mean	Weighted mean	Unweighted n	Unweighted mean	Weighted mean	Unweighted n	Unweighted mean	Weighted mean	Unweighted n	Unweighted mean	Weighted mean	Unweighted n	Unweighted mean	Weighted mean
Girls															
1	127	112.0	111.7	876	109.2	109.1	147	107.5	107.6	58	112.5		74	118.2	
2	974	112.7	112.6	2498	109.9	109.9	502	107.7	107.7	606	113.5		371	118.4	
3	1721	113.1	113.1	660	109.9	110.0	663	107.9	108.1	1053	113.3		456	118.4	
4	1697	113.4	113.3	1912	110.6	110.7	741	108.4	108.4	1585	113.8		869	118.7	
Total	4519	113.1	113.0	5946	110.0	110.1	2053	108.0	108.0	3302	113.6		1770	118.5	
Boys															
1	159	113.3	113.4	873	110.1	110.0	129	108.4	108.6	77	113.5		94	119.7	
2	1042	113.8	113.6	2688	110.7	110.7	525	108.8	108.9	705	114.4		367	119.3	
3	1720	114.2	114.1	683	111.3	111.2	705	108.9	108.9	1154	114.5		451	119.0	
4	1843	114.8	114.6	1992	111.7	111.8	779	109.3	109.3	1726	114.6		830	119.3	
Total	4764	114.3	114.2	6236	111.0	111.0	2138	109.0	109.0	3662	114.5		1742	119.2	

Table A.7-2: Height – unadjusted household income gradients

Equiv. household income quintile	Group A						Group B			Group C		
	ECLS-K (US)			MCS (UK)			LSAC-K (Australia)			Gen-R (Netherlands)		
	Unweighted		Weighted mean	Unweighted		Weighted mean	Unweighted		Weighted mean	Unweighted		Weighted mean
	n	mean		n	mean		n	mean		n	n	
Girls												
1	836	112.6	112.4	1261	109.4	109.4	358	107.3	107.3	317	118.4	
2	883	113.0	112.9	1259	109.7	109.6	386	107.5	107.6	340	118.6	
3	905	113.3	113.4	1181	110.1	110.1	386	108.0	108.0	327	119.0	
4	942	113.3	113.2	1150	110.3	110.3	402	108.5	108.7	342	118.2	
5	953	113.2	113.2	1089	110.8	110.8	462	108.4	108.5	334	118.7	
Total	4519	113.1	113.0	5940	110.0	110.1	1994	108.0	108.0	1660	118.6	
Boys												
1	845	113.6	113.4	1296	110.3	110.2	380	108.5	108.5	345	119.2	
2	947	114.4	114.2	1324	110.7	110.6	401	108.6	108.6	322	118.9	
3	959	114.4	114.3	1268	111.0	111.0	430	108.9	108.9	336	119.2	
4	1000	114.5	114.3	1213	111.3	111.4	427	109.1	109.1	321	119.4	
5	1013	114.7	114.6	1129	111.9	111.8	441	109.7	109.8	327	119.4	
Total	4764	114.3	114.2	6230	111.0	111.0	2079	109.0	109.0	1651	119.2	

Table A.7-3: Overweight/obesity – unadjusted parental education gradients

Parental education		Group A								Group B			
		ECLS-K (US)				MCS (UK)				LSAC-K (Australia)			
		Unweighted			Weighted	Unweighted			Weighted	Unweighted			Weighted
		n overweight/obese	total n	prop.	prop.	n overweight/ obese	total n	prop.	prop.	n overweight/ obese	total n	prop.	prop.
Girls	**1**	27	127	21.3%	21.7%	243	876	27.7%	26.3%	43	146	29.5%	27.9%
	2	215	973	22.1%	21.3%	624	2497	25.0%	23.5%	122	502	24.3%	23.9%
	3	365	1721	21.2%	20.3%	158	660	23.9%	23.8%	157	661	23.8%	23.9%
	4	282	1695	16.6%	16.7%	398	1907	20.9%	20.5%	148	741	20.0%	19.1%
	Total	889	4516	19.7%	19.3%	1423	5940	24.0%	22.9%	470	2050	22.9%	22.7%
Boys	**1**	25	159	15.7%	16.7%	187	872	21.4%	21.6%	22	128	17.2%	16.9%
	2	209	1042	20.1%	20.6%	550	2688	20.5%	19.5%	95	524	18.1%	17.7%
	3	301	1719	17.5%	18.1%	138	682	20.2%	19.2%	142	705	20.1%	20.3%
	4	263	1843	14.3%	14.6%	329	1989	16.5%	15.9%	129	777	16.6%	16.8%
	Total	798	4763	16.8%	17.4%	1204	6231	19.3%	18.5%	388	2134	18.2%	18.3%

Parental education		Group C							
		Gen-R (Netherlands)				ABIS (Sweden)			
		Unweighted			Weighted	Unweighted			Weighted
		n overweight/obese	total n	prop.	prop.	n overweight/obese	total n	prop.	prop.
Girls	**1**	23	74	31.1%	Not Avail.	12	51	23.5%	Not Avail.
	2	73	371	19.7%		123	549	22.4%	
	3	59	456	12.9%		191	963	19.8%	
	4	103	869	11.9%		258	1480	17.4%	
	Total	258	1770	14.6%		584	3043	19.2%	
Boys	**1**	17	94	18.1%		14	71	19.7%	
	2	56	367	15.3%		110	639	17.2%	
	3	43	451	9.5%		175	1073	16.3%	
	4	53	830	6.4%		204	1626	12.6%	
	Total	169	1742	9.7%		503	3409	14.8%	

Table A.7-4: Overweight/obesity – unadjusted household income gradients

	Group A								Group B				Group C			
	ECLS-K (US)				MCS (UK)				LSAC-K (Australia)				Gen-R			
	Unweighted				Unweighted				Unweighted				Unweighted			
Equiv. household income quintile	n over-weight/ obese	total n	prop.	Weighted prop.	n over-weight/ obese	total n	prop.	Weighted prop.	n over-weight/ obese	total n	prop.	Weighted prop.	n over-weight/ obese	total n	prop.	Weighted prop.
Girls																
1	185	835	22.2%	21.3%	330	1260	26.2%	24.5%	92	356	25.8%	24.8%	67	317	21.1%	
2	177	881	20.1%	19.9%	326	1259	25.9%	25.0%	81	386	21.0%	20.6%	44	340	12.9%	
3	178	905	19.7%	18.8%	265	1180	22.5%	21.8%	92	385	23.9%	23.6%	56	327	17.1%	
4	187	942	19.9%	19.7%	273	1149	23.8%	23.5%	91	402	22.6%	22.4%	33	342	9.7%	
5	162	953	17.0%	16.7%	234	1086	21.6%	20.0%	102	462	22.1%	22.7%	36	334	10.8%	
Total	889	4516	19.7%	19.3%	1428	5934	24.1%	23.0%	458	1991	23.0%	22.8%	236	1660	14.2%	
Boys																
1	163	845	19.3%	19.9%	275	1296	21.2%	20.8%	77	378	20.4%	20.8%	49	345	14.2%	
2	168	947	17.7%	19.0%	266	1323	20.1%	19.5%	75	401	18.7%	19.0%	36	322	11.2%	
3	170	958	17.8%	18.2%	241	1265	19.1%	18.1%	70	429	16.3%	15.1%	37	336	11.0%	
4	151	1000	15.1%	15.2%	241	1213	19.9%	18.7%	79	427	18.5%	18.8%	24	321	7.5%	
5	146	1013	14.4%	14.5%	183	1128	16.2%	15.9%	75	440	17.1%	17.3%	19	327	5.8%	
Total	798	4763	16.8%	17.4%	1206	6225	19.4%	18.6%	376	2075	18.1%	18.2%	165	1651	10.0%	

Table A.7-5: Excellent health – unadjusted parental education gradients

		Group A								Group B			
		ECLS-K (US)				MCS (UK)				LSAC-K (Australia)			
		Unweighted				Unweighted				Unweighted			
Parental education		n with excellent health	total n	prop.	Weighted prop.	n with excellent health	total n	prop.	Weighted prop.	n with excellent health	total n	prop.	Weighted prop.
Girls	**1**	45	134	33.6%	30.4%	411	887	46.3%	44.5%	78	149	52.4%	52.7%
	2	502	996	50.4%	48.7%	1343	2516	53.4%	52.5%	293	509	57.6%	56.9%
	3	1015	1747	58.1%	57.7%	415	668	62.1%	61.6%	407	666	61.1%	61.0%
	4	1166	1728	67.5%	67.3%	1207	1924	62.7%	61.8%	476	743	64.1%	63.4%
	Total	2728	4605	59.2%	58.1%	3376	5995	56.3%	55.4%	1254	2067	60.7%	60.0%
Boys	**1**	68	172	39.5%	38.9%	381	888	42.9%	42.5%	74	131	56.5%	59.0%
	2	543	1072	50.7%	50.4%	1325	2726	48.6%	49.1%	298	533	55.9%	55.9%
	3	934	1761	53.0%	52.4%	393	694	56.6%	55.5%	402	707	56.9%	56.2%
	4	1205	1879	64.1%	64.9%	1205	2003	60.2%	60.3%	442	784	56.4%	56.2%
	Total	2750	4884	56.3%	55.9%	3304	6311	52.4%	52.6%	1216	2155	56.4%	56.3%

		Group B								Group C			
		NLSCY (Canada)				QLSCD (Canada)				Gen-R (Netherlands)			
		Weighted				Unweighted				Unweighted			
Parental education		n with excellent health	total n	prop.		n with excellent health	total n	prop.	Weighted prop.	n with excellent health	total n	prop.	Weighted prop.
Girls	**1**	100	200	52.9%		39	74	52.7%	51.7%	8	40	20.0%	
	2	300	400	60.1%		72	138	52.2%	48.0%	86	293	29.4%	
	3	800	1100	67.7%		166	295	56.3%	56.2%	148	389	38.1%	
	4	600	800	71.9%		181	310	58.4%	57.6%	325	767	42.4%	
	Total	1700	2600	66.5%		458	817	56.1%	54.8%	567	1489	38.1%	
Boys	**1**	100	200	61.0%		28	58	48.3%	47.9%	6	55	10.9%	
	2	300	500	60.7%		59	112	52.7%	53.7%	87	287	30.3%	
	3	600	1100	56.3%		184	338	54.4%	54.7%	128	395	32.4%	
	4	500	800	66.1%		183	287	63.8%	60.7%	316	751	42.1%	
	Total	1500	2500	60.6%		454	795	57.1%	55.9%	537	1488	36.1%	

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Table A.7-6: Excellent health – unadjusted household income gradients

Equiv. household income quintile	Group A								Group B			
	MCS (UK)				ECLS-K (US)				LSAC-K (Australia)			
	Unweighted				Unweighted				Unweighted			
	n with excellent health	total n	prop.	Weighted prop.	n with excellent health	total n	prop.	Weighted prop.	n with excellent health	total n	prop.	Weighted prop.
Girls												
1	612	1283	47.7%	47.4%	392	864	45.4%	44.2%	216	364	59.3%	59.8%
2	639	1276	50.1%	46.3%	505	899	56.2%	55.9%	211	390	54.1%	54.0%
3	678	1190	57.0%	56.5%	561	925	60.7%	60.4%	225	386	58.3%	57.0%
4	703	1156	60.8%	60.0%	611	951	64.3%	62.4%	251	402	62.4%	61.9%
5	738	1096	67.3%	66.5%	659	966	68.2%	68.0%	312	464	67.2%	66.2%
Total	3370	6001	56.2%	55.3%	2728	4605	59.2%	58.1%	1215	2006	60.6%	59.9%
Boys			0.0%				0.0%				0.0%	
1	593	1332	44.5%	43.5%	396	883	44.9%	44.3%	204	385	53.0%	53.5%
2	647	1350	47.9%	48.7%	497	964	51.6%	51.9%	217	405	53.6%	52.8%
3	663	1279	51.8%	51.8%	573	988	58.0%	57.9%	254	432	58.8%	58.7%
4	684	1221	56.0%	55.9%	606	1015	59.7%	60.2%	262	432	60.7%	60.8%
5	721	1139	63.3%	61.9%	678	1034	65.6%	65.1%	244	442	55.2%	55.2%
Total	3308	6321	52.3%	52.4%	2750	4884	56.3%	55.9%	1181	2096	56.4%	56.3%

(Table A.7-6 continued)

Equiv. household income quintile	Group B								Group C			
	NLSCY (Canada)				QLSCD (Canada)				Gen-R (Netherlands)			
	Weighted				Unweighted				Unweighted			
	n with excellent health	total n	prop.	Weighted prop.	n with excellent health	total n	prop.	Weighted prop.	n with excellent health	total n	prop.	Weighted prop.
Girls												
1	300	500	57.8%		68	141	48.2%	47.2%	71	249	28.5%	
2	400	500	65.1%		80	154	52.0%	50.0%	98	290	33.8%	
3	400	600	64.1%		78	148	52.7%	52.2%	108	291	37.1%	
4	400	500	70.1%		94	165	57.0%	56.8%	132	315	41.9%	
5	400	500	75.8%		117	176	66.5%	65.3%	140	300	46.7%	
Total	1800	2600	66.4%		437	784	55.7%	54.3%	549	1445	38.0%	
Boys							0.0%				0.0%	
1	300	500	54.3%		64	125	51.2%	51.2%	73	275	26.6%	
2	300	500	52.1%		65	145	44.8%	42.6%	89	277	32.1%	
3	300	500	57.6%		96	165	58.2%	57.2%	110	302	36.4%	
4	300	500	63.9%		101	166	60.8%	61.7%	116	293	39.6%	
5	400	600	72.9%		112	164	68.3%	68.6%	138	298	46.3%	
Total	1600	2600	60.4%		438	765	57.3%	56.2%	526	1445	36.4%	

Table A.7-7: Chronic illness – unadjusted parental education gradients

	Group A				Group B															
	MCS (UK) (UK)				LSAC-K (Australia)				NLSCY (Canada)			QLSCD (Canada)				ABIS (Sweden)				
	Unweighted				Unweighted				Weighted			Unweighted				Unweighted				
Parent education	n with illness	total n	prop.	Weighted prop.	n with illness	total n	prop.	Weighted prop.	n with illness	total n	prop.	n with illness	total n	prop.	Weighted prop.	n with illness	total n	prop.	Weighted prop.
Girls																			
1	185	886	20.9%	21.0%	37	149	24.8%	26.5%	0	200	21.8%	25	74	33.8%	35.4%	9	62	14.5%	
2	453	2515	18.0%	18.2%	104	509	20.4%	20.7%	100	400	15.5%	31	138	22.5%	22.9%	114	620	18.4%	
3	107	668	16.0%	15.2%	113	667	16.9%	17.0%	200	1100	16.9%	67	295	22.7%	22.8%	195	1073	18.2%	
4	301	1923	15.7%	15.7%	99	743	13.3%	14.0%	200	800	18.3%	59	310	19.0%	18.5%	288	1619	17.8%	
Total	1046	5992	17.5%	17.5%	353	2068	17.1%	17.8%	500	2600	17.5%	182	817	22.3%	22.7%	606	3374	18.0%	
Boys																			
1	249	887	28.1%	26.9%	39	131	29.8%	30.2%	0	200	21.8%	15	58	25.9%	25.4%	20	81	24.7%	
2	613	2725	22.5%	22.6%	151	533	28.3%	28.2%	100	400	22.0%	28	112	25.0%	27.7%	175	724	24.2%	
3	155	694	22.3%	23.5%	187	707	26.5%	26.9%	200	1100	22.6%	92	338	27.2%	26.6%	282	1172	24.1%	
4	402	2003	20.1%	19.4%	158	784	20.2%	20.0%	200	800	21.4%	85	287	29.6%	29.1%	412	1752	23.5%	
Total	1419	6309	22.5%	22.2%	535	2155	24.8%	25.3%	600	2500	22.0%	220	795	27.7%	27.5%	889	3729	23.8%	

Table A.7-8: Chronic illness – unadjusted household income gradients

	Group A				Group B										
	MCS (UK)				LSAC-K (Australia)				NLSCY (Canada)			QLSCD (Canada)			
	Unweighted				Unweighted				Weighted			Unweighted			
Equiv. household income quintile	n with chronic illness	total n	prop.	Weighted prop.	n with chronic illness	total n	Weighted prop.	Weighted prop.	n with chronic illness	total n	Weighted prop.	n with chronic illness	total n	prop.	Weighted prop.
Girls															
1	270	1283	21.0%	20.8%	76	365	20.8%	22.1%	100	500	22.4%	41	141	29.1%	31.2%
2	244	1275	19.1%	18.8%	85	390	21.8%	22.5%	100	500	17.1%	30	154	19.5%	17.4%
3	202	1189	17.0%	17.7%	63	386	16.3%	16.3%	100	600	15.4%	31	148	21.0%	21.8%
4	179	1156	15.5%	15.8%	67	402	16.7%	17.4%	100	500	16.5%	42	165	25.5%	24.9%
5	156	1094	14.3%	14.6%	56	464	12.1%	12.3%	100	500	16.3%	31	176	17.6%	17.7%
Total	1051	5997	17.5%	17.5%	347	2007	17.3%	18.1%	500	2600	17.5%	175	784	22.3%	22.7%
Boys							0.0%							0.0%	
1	354	1331	26.6%	27.3%	127	385	33.0%	33.4%	100	500	22.8%	36	125	28.8%	27.2%
2	337	1349	25.0%	24.8%	104	405	25.7%	26.0%	100	500	25.3%	40	145	27.6%	29.1%
3	293	1279	22.9%	22.2%	102	432	23.6%	23.8%	100	500	20.9%	42	165	25.5%	25.7%
4	229	1221	18.8%	18.2%	100	432	23.2%	23.4%	100	500	22.2%	44	166	26.5%	26.9%
5	215	1139	18.9%	19.1%	89	442	20.1%	20.1%	100	600	19.9%	51	164	31.1%	28.7%
Total	1428	6319	22.6%	22.3%	522	2096	24.9%	25.4%	600	2600	22.2%	213	765	27.8%	27.5%

Table A.7-9: Emotional problems and anxiety standardised scores– unadjusted parental education gradients

	Group A			Group B											
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)			QLSCD (Canada)			Gen-R (Netherlands)		
Parental	Unweighted		Weighted	Unweighted		Weighted	Unweighted		Weighted	Unweighted		Weighted	Unweighted		
education	n	mean	mean	n	mean	mean	n	mean	mean	n	mean	mean	n	mean	Weighted
Girls															
1	866	0.30	0.29	149	0.35	0.33			0.0	74	0.11	0.03	54	0.22	
2	2496	0.04	0.03	508	0.04	0.05			-0.1	138	0.05	0.07	342	0.11	
3	665	-0.06	-0.01	665	-0.02	0.00			0.1	295	0.03	0.05	443	0.02	
4	1918	-0.08	-0.07	743	-0.16	-0.15			0.0	310	-0.07	-0.06	837	-0.07	
Total	5945	0.03	0.03	2065	-0.03	0.00			0.0	817	0.00	0.02	1676	0.00	
Boys															
1	869	0.29	0.25	130	0.15	0.14			0.0	58	0.00	0.04	69	0.48	
2	2704	0.00	0.02	533	0.10	0.13			-0.1	112	-0.06	0.00	348	0.12	
3	690	-0.14	-0.15	707	-0.02	-0.01			0.0	338	0.04	0.06	445	-0.03	
4	1993	-0.14	-0.16	782	-0.14	-0.14			0.0	287	-0.12	-0.14	807	-0.08	
Total	6256	-0.02	-0.03	2152	-0.02	0.00			0.0	795	-0.03	-0.02	1669	0.00	

Table A.7-10: Emotional problems and anxiety standardised scores – unadjusted household income gradients

Equiv. household income quintile	Group A			Group B											
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)			QLSCD (Canada)			Gen-R (Netherlands)		
	Unweighted		Weighted mean	Unweighted		Weighted mean	Unweighted		Weighted mean	Unweighted		Weighted mean	Unweighted		Weighted mean
	n	mean		n	mean		n	mean		n	mean		n	mean	
Girls															
1	1256	0.27	0.28	364	0.25	0.29			0.0	141	0.18	0.15	315	0.16	
2	1262	0.10	0.09	389	0.01	0.04			0.0	154	0.04	0.02	338	0.05	
3	1185	-0.05	-0.05	385	0.02	0.02			0.0	148	-0.04	0.00	327	-0.02	
4	1155	-0.06	-0.04	402	-0.16	-0.15			-0.1	165	-0.04	-0.05	341	-0.05	
5	1093	-0.14	-0.14	464	-0.19	-0.17			0.1	176	-0.11	-0.11	332	-0.14	
Total	5951	0.03	0.03	2004	-0.02	0.00			0.0	784	0.00	0.00	1653	0.00	
Boys															
1	1308	0.19	0.19	384	0.22	0.24			0.1	125	0.12	0.14	338	0.20	
2	1336	0.07	0.05	404	0.06	0.08			0.0	145	0.09	0.08	322	0.12	
3	1271	-0.05	-0.05	432	-0.01	0.03			0.0	165	-0.02	0.01	334	-0.06	
4	1218	-0.10	-0.08	432	-0.12	-0.12			-0.1	166	-0.18	-0.18	320	-0.11	
5	1137	-0.24	-0.25	441	-0.22	-0.23			0.0	164	-0.20	-0.23	327	-0.17	
Total	6270	-0.02	-0.03	2093	-0.02	0.00			0.0	765	-0.05	-0.04	1641	0.00	

Table A.7-11: Hyperactivity and inattention standardised scores – unadjusted parental education gradients

Parental education	Group A			Group B									Group C		
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)			QLSCD (Canada)			Gen-R (Netherlands)		
	Unweighted		Weighted	Unweighted		Weighted	Unweighted		Weighted	Unweighted		Weighted	Unweighted		Weighted
	n	mean	mean	n	mean	mean	n	mean	mean	n	mean	mean	n	mean	mean
Girls															
1	863	0.24	0.23	149	0.23	0.22			0.2	74	0.01	0.11	54	0.24	
2	2486	-0.05	-0.03	508	0.03	0.05			-0.1	138	0.00	-0.01	342	0.19	
3	664	-0.25	-0.23	665	-0.18	-0.16			-0.1	295	-0.07	-0.04	443	-0.10	
4	1918	-0.43	-0.41	743	-0.54	-0.52			-0.3	310	-0.36	-0.38	837	-0.25	
Total	5931	-0.15	-0.14	2065	-0.23	-0.18			-0.1	817	-0.16	-0.14	1676	-0.11	
Boys															
1	867	0.53	0.53	131	0.47	0.46			0.4	58	0.31	0.21	69	0.78	
2	2700	0.26	0.26	533	0.30	0.32			0.2	112	0.31	0.34	347	0.34	
3	688	0.06	0.04	707	0.24	0.25			0.2	338	0.20	0.21	444	0.15	
4	1992	-0.13	-0.13	782	-0.13	-0.11			-0.1	287	-0.04	-0.06	807	-0.08	
Total	6247	0.15	0.14	2153	0.14	0.17			0.1	795	0.14	0.14	1667	0.11	

Table A.7-12: Hyperactivity and inattention standardised scores – unadjusted household income gradients

Equiv. household income quintile	Group A			Group B									Group C		
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)			QLSCD (Canada)			Gen-R (Netherlands)		
	Unweighted		Weighted	Unweighted		Weighted	Unweighted		Weighted	Unweighted		Weighted	Unweighted		Weighted
	n	mean	mean	n	mean	mean	n	mean	mean	n	mean	mean	n	mean	mean
Girls															
1	1251	0.14	0.13	364	0.04	0.07			0.2	141	0.03	0.08	316	0.13	
2	1253	0.03	0.05	389	-0.04	-0.01			-0.2	154	-0.03	-0.04	337	-0.03	
3	1185	-0.19	-0.16	385	-0.20	-0.17			-0.2	148	-0.19	-0.20	327	-0.13	
4	1155	-0.34	-0.31	402	-0.35	-0.30			-0.3	165	-0.24	-0.24	341	-0.21	
5	1093	-0.45	-0.43	464	-0.51	-0.49			-0.2	176	-0.40	-0.41	332	-0.30	
Total	5937	-0.15	-0.15	2004	-0.23	-0.18			-0.1	784	-0.18	-0.16	1653	-0.11	
Boys															
1	1306	0.49	0.47	385	0.39	0.43			0.3	125	0.39	0.35	338	0.41	
2	1334	0.27	0.28	404	0.25	0.29			0.1	145	0.33	0.30	321	0.26	
3	1269	0.10	0.11	432	0.15	0.15			0.2	165	0.08	0.09	333	-0.04	
4	1215	-0.01	0.00	432	0.08	0.10			0.1	166	0.15	0.15	320	-0.03	
5	1137	-0.14	-0.14	441	-0.14	-0.13			0.0	164	-0.23	-0.24	327	-0.10	
Total	6261	0.15	0.14	2094	0.14	0.17			0.1	765	0.13	0.13	1639	0.10	

Table A.7-13: Verbal cognition standardised scores – unadjusted parental education gradients

	Group A			Group B					
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)		
	Unweighted		Weighted mean	Unweighted		Weighted mean	Unweighted		Weighted mean
Parental education	n	mean		n	mean		n	mean	
Girls									
1	873	-0.47	-0.45	131	-0.48	-0.49			-0.4
2	2495	-0.10	-0.09	447	-0.07	-0.08			-0.2
3	661	0.13	0.21	600	0.04	0.03			0.1
4	1910	0.31	0.34	680	0.40	0.39			0.3
Total	5939	0.00	0.03	1858	0.11	0.07			0.1
Boys									
1	864	-0.48	-0.52	107	-0.42	-0.40			-0.6
2	2685	-0.20	-0.21	468	-0.19	-0.20			-0.4
3	684	0.09	0.14	645	-0.12	-0.15			-0.1
4	1987	0.32	0.36	703	0.20	0.19			0.2
Total	6220	-0.04	-0.02	1923	-0.04	-0.07			-0.1

Table A.7-14: Verbal cognition standardised scores – unadjusted household income gradients

	Group A			Group B					
	MCS (UK)			LSAC-K (Australia)			NLSCY (Canada)		
	Unweighted		Weighted mean	Unweighted		Weighte d mean	Unweighted		Weighted mean
Equiv. household income quintile	n	mean		n	mean		n	mean	
Girls									
1	1255	-0.35	-0.36	315	-0.20	-0.20			-0.2
2	1259	-0.16	-0.13	359	-0.09	-0.14			0.0
3	1180	0.04	0.06	348	0.13	0.12			0.1
4	1149	0.21	0.22	364	0.28	0.25			0.2
5	1088	0.34	0.37	422	0.35	0.33			0.3
Total	5931	0.00	0.03	1808	0.11	0.07			0.1
Boys									
1	1295	-0.39	-0.40	327	-0.36	-0.38			-0.4
2	1313	-0.23	-0.24	368	-0.14	-0.18			-0.2
3	1266	-0.02	-0.02	397	-0.04	-0.04			-0.1
4	1212	0.14	0.14	401	0.07	0.03			0.0
5	1128	0.35	0.37	385	0.26	0.24			0.2
Total	6214	-0.04	-0.03	1878	-0.03	-0.06			-0.1

Abbreviations

All Babies in Southeast Sweden study (ABIS)

Body Mass Index (BMI)

British Ability Scale(BAS)

Early Child Longitudinal Study – Kindergarten Cohort (ECLS-K)

European Union Statistics on Income and Living Conditions (EU-SILC)

Generation-R study (Gen-R)

Gross Domestic Product (GDP)

Gross National Income (GNI)

Hypothalamic-pituitary-adrenocortical circuit (HPA)

International Network for Research on Inequalities in Child Health (INRICH)

Millennium Cohort Study (MCS)

National Longitudinal Survey of Children and Youth (NLSCY)

Netherlands (Neth.)

Odds Ratio (OR)

Organisation for Economic Cooperation and Development (OECD)

Picture Peabody Vocabulary Test (PPVT)

Programme for the International Assessment of Adult Competencies (PIAAC)

Programme of International Student Assessment (PISA)

Purchasing Power Parity (PPP)

Quebec Longitudinal Study of Child Development (QLSCD)

Relative Index of Inequality (RII)

Slope Index of Inequality (SII)

Socioeconomic Position (SEP)

Standard Error (SE)

Standardised World Income Inequality Database (SWIID)

Strengths and Difficulties Questionnaire (SDQ)

Subjective Social Status (SSS)

The Longitudinal Study of Australian Children – Kindergarten Cohort (LSAC-K)

United Kingdom (UK)

United Nations Children’s Fund (UNICEF)

United States (US)

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